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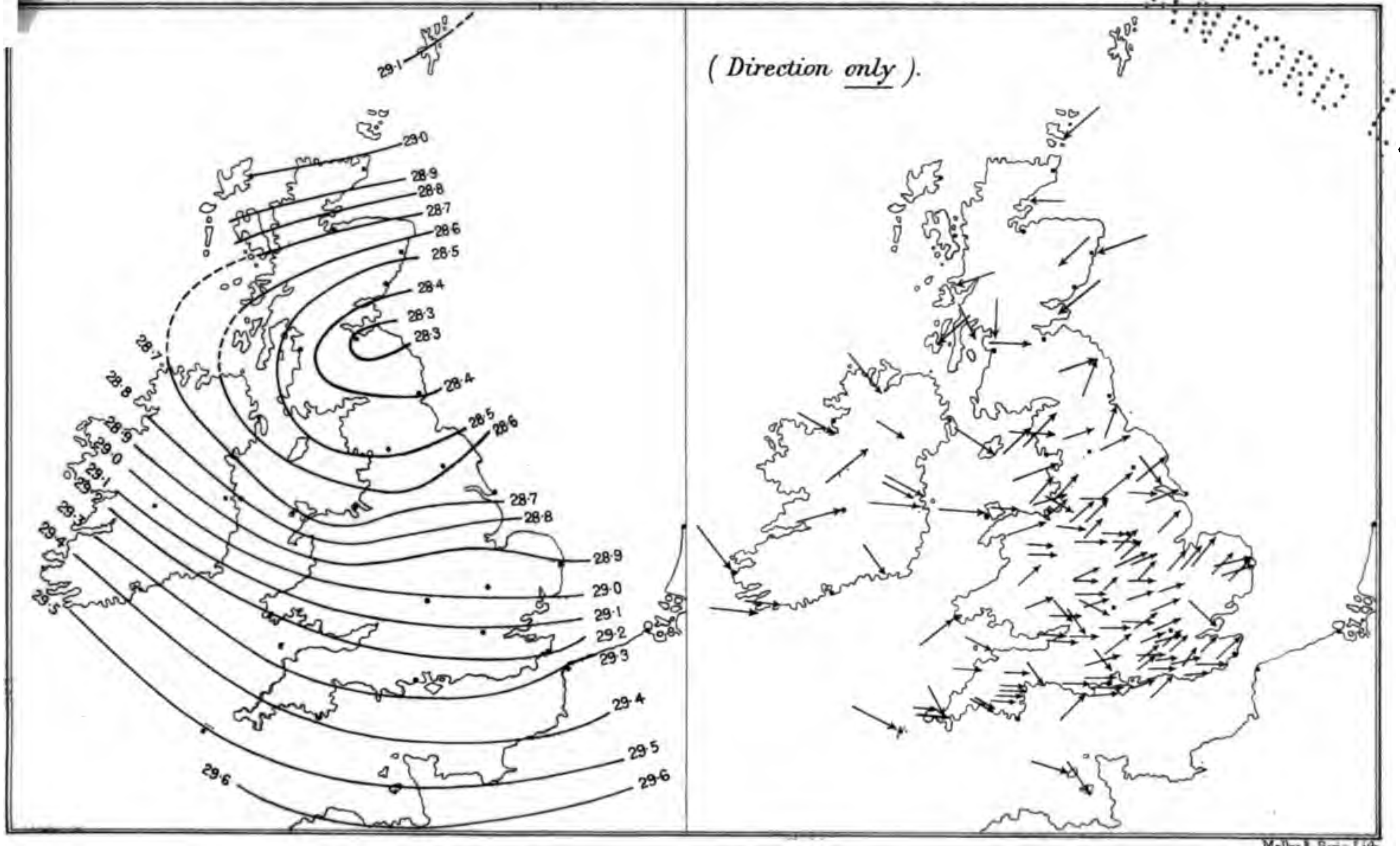

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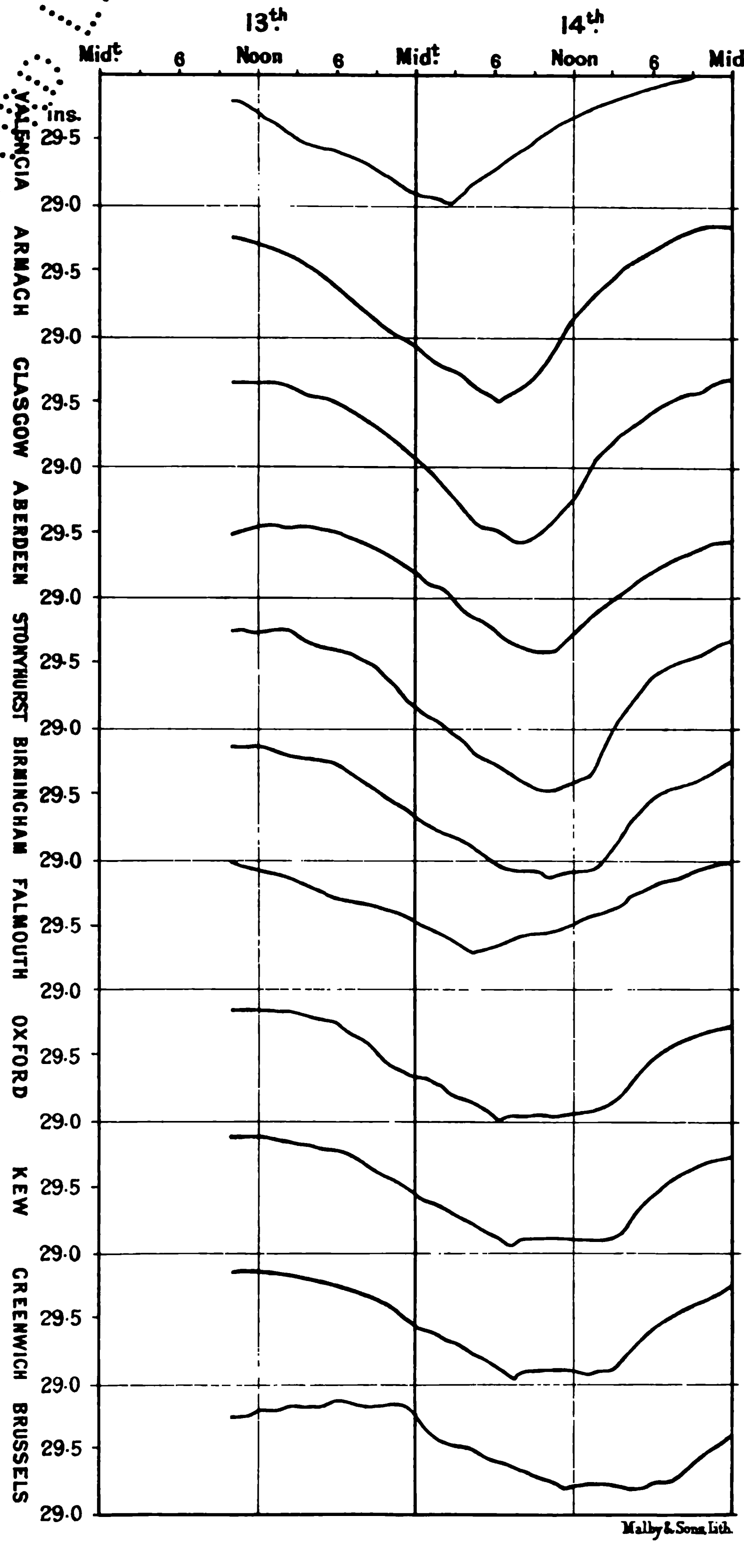

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THE METEOROLOGICAL SOCIETY.

VOL. VIII. No. 41

ON THE GALE OF OCTOBER 13TH-14TH, 1881, OVER THE BRITISH ISLES. By G. J. SYMONS, F.R.S., President. (Plates I. and II.)

[Read November 16th, 1881.]

WITH the steady onward progress of Meteorology the character of the descriptions of Meteorological phenomena necessarily changes, and besides changing, the records become much more voluminous. They change, because the desire of the present day is to have facts rather than graphic descriptions, to have the records of instruments rather than personal opinions, or sensations. Descriptions become more voluminous for many reasons: there are ten times as many observers as there were but a short time back, there are many more instruments at work, and the newspaper press, the postal system, and the telegraph, all tend to bring before the world many facts, of which in bygone years not a word would have been heard outside, perhaps, the mere county in which they occurred.

But it would never do to shrink from investigating phenomena, because the task is heavy, or because, to do it exhaustively, six months might be devoted to it. I venture to hold that the wisest course is to face the difficulty—which is a very real one—and to do your best. That at any rate is what I have done, and before I go another step, I desire to say that it will give me extreme pleasure to hand over to any one who has six months to spare, the originals whence I have prepared the remarks I am about to offer.

It has been remarked, that if this paper had been postponed for a few months, more data respecting the earlier stages of the storm would have been available. This is obviously true, but fortunately our discussing it now by no means prevents its being subsequently further investigated—on the contrary, as by prompt action we have collected an enormous mass of data, while the facts are fresh in the memory of all, we bring its general features forward at once, and I trust that, as it is scarcely more than a month since

the storm swept over these islands, the discussion to-night will be unusually useful in clearing up doubtful points, in supplying omissions, and in correcting erroneous inferences. The more that is done in these respects, the better will it be for the science we follow.

It is usual to reserve for the conclusion of a paper the recognition of any assistance which the author may have received—but I reverse the practice, for two reasons: firstly, because the assistance has been so great that its importance exceeds that of my own share in the work; and secondly, because it is only by entering rather fully into explanations as to the division of labour that I can indicate the mode in which I intend to lay the facts before you.

As soon as it had been resolved that the subject should be brought before the meeting this evening, I received many valuable offers of assistance, all which have been amply fulfilled. Mr. Scott promised the help of the Meteorological Office, and has throughout assisted in every possible way; Mr. Rogers Field undertook to have the diagrams enlarged; Mr. Charles Harding offered to collect all the information which he could respecting shipping disasters, and in so doing, he has had important help from the Meteorological Council, and from the head quarters of Shipping Intelligence, viz. Lloyd's.

I was from the first very desirous of collecting information as to the indications of wind pressure which could be obtained from structural damage, e.g. that a mass of stone offering x superficial feet to the wind and weighing y pounds was overthrown, indicating a wind force of not less than z lbs. per square foot; and I therefore learnt with great pleasure that Mr. J. Wallace Peggs had already collected some data of this kind. I have therefore turned over to him such facts of structural damage as I collected, and he has prepared the paper which will follow mine; and I thought it had better stand as it does, as an independent one, than as an Appendix to my own.

Mr. Harding's paper too will appear separately from this one, as the information it contains, relating exclusively to the sea, entitles it to consideration apart from the records of the storm on shore.

The reduction of the anemograms has been made chiefly by Mr. Curtis, but partly by Mr. Constable. The reduction of the barograms, the tabulation of the barometer readings, the plotting of the wind on the charts and the drawing of the isobars, as well as the general preparation of the paper, have been shared between Mr. H. Sowerby Wallis and myself.

It will thus be seen that I was fully justified in stating that the work of my colleagues is collectively greater than my own.

It is in the next place necessary to state what steps have been taken to collect information, and with what result. The suggestion of preparing the paper was adopted by the Council on October 19th, and within 24 hours a Circular had been prepared, printed, addressed and posted to nearly 400 observers who were either known, or who were considered to be, either using standard instruments, or otherwise able to furnish valuable information. The response was exactly what previous experience has led me to expect, namely, the prompt despatch of all the information which the great

majority of these 400 observers could furnish. Of course it was impossible—would have been waste of time—to acknowledge these communications; the best possible acknowledgment has been to do my utmost to turn them to good effect.

Most of the returns were extremely satisfactory, and some, notably that from the Royal Observatory, Greenwich, were remarkably good. But there are one or two cases in which I should like to see valuable instruments receive better treatment than they do. It is hardly pleasant (especially remembering the adage respecting a gift horse) to write to any one and suggest improvements; but as a very old Fellow of the Society, I feel it partly my duty to urge two points, (1) that self-recording barographs, no matter what be the pattern, should not be left to run for 24 hours with only one reading of the standard to check them. At Greenwich and Oxford, and at all the observatories of the Meteorological Council, there are automatic indications of the time scale, and where there are no such arrangements they ought to be introduced, while at least three times in every 24 hours there ought to be an eye reading to check the indications of the barogram. (2). It would be little individual trouble if observers, besides sending the uncorrected readings of their barometers, sent also the equivalent sea-level pressure. It is not much trouble to reduce half a dozen readings, but when there are a hundred times half a dozen, the work becomes heavy.

Before entering upon the description of the storm, I think that it is desirable to say a few words which may be useful in keeping the discussion from becoming discursive. No one yet knows precisely what is the distinction between a so-called whirlwind and a so-called cyclone, or as it is popularly called, a storm. The broad distinguishing features of the two classes are that the energy is concentrated in the former, while it covers a large area in the latter. In the path of a so-called whirlwind the mechanical force exerted is sometimes almost beyond belief; and it is not merely, or perhaps chiefly, lateral force which is developed, but there is, to my mind, overwhelming evidence of the passage of a very small area of greatly reduced atmospheric pressure. I believe that no mercurial barograph yet made could record the oscillation of pressure during the passage of such a whirlwind as, for example, the Walmer one. Possibly it might be done with some such instrument as the self-recording aneroid at Montsouris; but even if the instrument were in readiness, all experience shows that it would probably be a thousand years before a whirlwind passed over it, so rare are their occurrences and so narrow are their tracks. But there can be no harm in stating my own impression, which is, that with a whirlwind ¼ of a mile wide the barometer would be 0·2 inch lower in the centre than on either side, which would perhaps give a lifting power to the air in buildings over which it passed of about 14 lbs. per square foot. This gives a gradient of 0·8 in. *per mile*, a phenomenon of which, of course, there is no record whatever. But, on the other hand, we have records of the vertical lifting of slated roofs, and the simultaneous outward explosion of the walls of houses even *towards* the wind. The essential characteristics of a so-called whirlwind may be stated as (*a*) a very narrow path—from 100 to 1,000 feet wide, and

from ½ a mile to perhaps, but rarely, 10 or 20 miles long; (*b*) great damage within the track and scarcely any outside; (*c*) a column of dense vapour like smoke, and (*d*) a mass of fragments of trees usually occupying the centre of the path, and progressing but slowly, perhaps at the rate of from 6 to 10 miles per hour.

A storm is a very different phenomenon, often more than a thousand times greater in breadth, unaccompanied by any such excessive barometric differences as those I have just mentioned; never, in this country, producing the expansive or explosive effects common with whirlwinds, and rarely developing anything like the mechanical energy of the smaller phenomenon.

I am inclined to think (although I have never yet seen it proved) that small whirlwinds, or at any rate, streams of air at high velocity, and therefore possessing special destructive force, frequently pass along with, and through, the larger storms. I do not quite see what trace of such phenomena we ought to expect to find in the records of our, at present rather widely separated, fixed observatories. Possibly we may regard as such, the curious little depression which is visible in the traces of the barograms at Oxford, Kew, Camden Square, and Greenwich.

Mr. C. Harding's charts will show that the storm we are now to discuss originated to the southward of Newfoundland as early as October 10th, and that by noon on the 13th it had travelled to about longitude 28° W or, say, 500 miles west of Galway, and had developed into a storm of considerable energy. At that time there were scarcely any instrumental indications in the British Isles of its approach; the barometer was falling at Valencia, but not rapidly, and at some of the western English stations, Birmingham for example, it was still rising. The Daily Weather Report for 8 a.m. of that day showed that a large depression was lying over Norway, with westerly or north-westerly winds blowing over the British Isles; but by 2 p.m. the fall of the barometer had become general over Ireland, and had extended to the western part of England; and at 6 p.m. the advance of the depression was still more clearly indicated by the barometer in north-west Ireland having fallen more than half-an-inch since 8 a.m., the wind having in the meanwhile backed to south-east, from which point it blew freshly. The chart of barometric pressure for 9 a.m. on the 14th shows that during the night the centre of the depression had passed across the north of Ireland and was then lying over the south-east of Scotland, in which district the fall of the barometer had been very rapid, amounting at Leith to 1·11 in. between 6 p.m. on the 13th and 8 a.m. on the 14th. From the chart it will be seen that the lowest readings were at that time over Haddingtonshire, which is enclosed by the isobar for 28·8 ins.

Another of the charts prepared by Mr. C. Harding indicates the position of the centre at noon on the 14th over the North Sea, some 100 miles from the British coast; and by 6 p.m. it had very nearly reached the Danish coast; so that during the day it had continued to travel at an average rate of rather less than 40 miles per hour.

It is a point worthy of remark that the barometrical gradients were by

no means so steep in front of, and near, the centre of the disturbance as at some distance in its rear. A glance at the 9 a.m. chart of pressure will show that the steepest gradients were at that time over St. George's Channel and its neighbourhood, where the wind blew with great force all the morning. The difference between the 8 a.m. readings at Shields and Barrow was only ·06 in. at that hour; and between Shields and Mullaghmore it was but a quarter of an inch; but owing to the rapid rise of the barometer which occurred at the latter place immediately after the centre of the storm had passed to the E, the difference between the two stations had increased by 2 p.m. to an inch; decreasing again to half-an-inch by 6 p.m., when the barometer had been rising for some hours at Shields. This rapid change in the gradient accounts for the fact, noticed by most observers in the north of England and Ireland, of the *suddenness* with which the force of the gale burst upon them, simultaneously with a shift of the wind to North-west, and not until some time after the barometer had commenced to rise.

The sheet of barometric curves (Plate I.) shows very plainly this progress of the depression from west to east, for whilst at Valencia the minimum occurred about 2 a.m. on the 14th, at Armagh it did not occur till 6 a.m.; at Glasgow a little after 8 a.m., and at Aberdeen not until nearly 10 a.m. The track of the storm-centre lay probably sufficiently near to Armagh and Glasgow to allow of the use of the times of the minima at those stations for obtaining approximately its rate of progress during the early hours of the 14th, and the rate thus obtained, about 40 miles per hour, agrees very closely with the rate already given for the latter part of the day.

It may be worth noting that observers in Derry and Berwick report an unusual darkness in the SE, which continued for some hours prior to the outburst of the storm.

On examining the records of damage I found that there was one fortunate coincidence—in many parts the greatest damage occurred at about the time for which the largest number of accurate observations were sent in, viz. 9 a.m. on the 14th. I have, therefore, endeavoured to make charts which should as truthfully as possible represent the conditions prevailing at that hour. (Pl. II.)

In the first chart (Pl. II. No. 1) I have, in order to make it as clear and intelligible as possible, put nothing except lines which represent the pressures prevailing at the localities over which they pass. The isobars are not so symmetrical as those sometimes seen, but persons accustomed to such work as drawing isobars know that the more numerous the observations are, the more difficult is it to fit in perfectly symmetrical lines; and with such a rapid fall and rise of the barometer as we are now considering, an observation made even five minutes from the proper time is sure to throw one line wrong. The curves of hourly fluctuations have been utilised (by a method perhaps liable to an error of 0·02 in. or 0·03 in., but which in this discussion is unimportant) for the conversion of 8 a.m. observations into 9 a.m. observations. This done, the whole of the values were charted and the isobars very carefully drawn.

In the second chart (Pl. II. No. 2) I have endeavoured to represent the direction of the wind for the same hour, placing on it an arrow indicating the direction reported by each of several hundred observers. Even where, as for instance in Essex, I have felt nearly sure that the direction reported was incorrect, it has been neither suppressed nor altered, because it seemed very desirable to keep quite clear of theories and to give nothing but recorded facts, the map showing that the number of correct observations was sufficiently great to swamp (if the expression may be permitted) those which are inaccurate either from bad position or inaccurate observation. Putting down the whole of the records exactly as they stand in the MS. Reports, we find that at 9 a.m. on October 14th we have the general direction N in the south-west of Scotland, NE in the east of Scotland, SW in the north and east of England, WSW in the south-east of England, and WNW in the south-west of England.

The changes in the direction of the wind recorded by the various anemometers during the passage of the storm are interesting. At Armagh and Alnwick—the two stations nearest its path on its southern side—the wind, after backing to the south-east, suddenly *veered* to the westward and on to north-west, the change at Armagh being almost synchronous with the commencement of the recovery of pressure. At Glasgow, Dunecht and Aberdeen, stations to the north of the centre, the wind on the contrary steadily *backed* as the centre approached and passed. At the more southern stations the *veering* was more gradual, its commencement preceding by some hours the rise of the barometer.

As regards force, the estimates vary so greatly and so irregularly, that I have thought it best not to indicate the values upon the map; the exceptionally gusty character of the wind is, however, a fact mentioned by many observers, and one which may help in a great measure to explain the specially destructive character of the gale. The hourly velocities recorded by anemometers were nowhere remarkably great, and in many cases were decidedly small, not approaching the records of the same instruments during other and less destructive gales; the records of instruments in different parts of the country do not, however, appear at all harmonious or comparable, and putting aside all questions of gusts, and taking for comparison the greatest horizontal motion during any entire hour, we have:—

		Miles.			Miles.
Middlesex	Bromley	44	Cornwall	Falmouth	57
Surrey	Kew	45	Lancashire	Stonyhurst	41
,,	Croydon	36	Lanarkshire	Glasgow	88
Kent	Greenwich	68	Aberdeen	Dunecht	41
Oxford	Oxford	70	,,	Aberdeen	74
Norfolk	Norwich	36	Kerry	Valencia	58
Devon	Torquay	58	Armagh	Armagh	24

How can one believe that nearly twice as much wind passed over Greenwich as over Croydon? or again over Oxford as over Norwich, when we know that the damage was greater in Norfolk than in Oxford? Something

might perhaps be ascertained by comparing the values at each station with those previously recorded at each, but the records are evidently chiefly indicative of the very different conditions in which the instruments are placed.

I have only received the records of two pressure anemometers, and they appear no more comparable than the velocity ones. At the Royal Observatory the extreme pressure of 53 lbs. per square foot was recorded. On the top of the Royal Exchange the anemometer never indicated 19 lbs., *i.e.* the maximum there was little more than one-third of that recorded at Greenwich.

The observer at Alnwick, where more than 4,000 trees were overthrown, reported that on climbing a hill near the town he could see "in various directions lanes cut through the woods." I asked for a photograph showing these lanes, but he replied that no photograph would so show them that a stranger could recognise them, and therefore he sent an ordnance map with these lanes marked—they all run parallel, and about from NNW to SSE.

A member of the Council expressed the hope that details would be given respecting the rainfall previous to the storm; and accordingly records from about 100 stations have been tabulated for the three days—October 13th, 14th, and 15th. It is not necessary to reproduce these tables, for the facts are in no respect exceptional. In the twenty-four hours ending 9 a.m. 13th the rainfall at no station amounted to an inch, and at very few reached half an inch—perhaps the average might be put at a quarter of an inch—but over large districts no rain at all fell. In the following 24 hours, viz. between 9 a.m. on 13th and 9 a.m. 14th, *i.e.* in the period preceding the epoch of the two charts, a moderate rain fell—the heaviest fall in the month but not by any means what can be regarded as an exceptional fall, it certainly did not average an inch. The only districts where the fall was at all worthy of notice were, the extreme south-west of Ireland, where at one station 2·45 ins. fell; and in Central Wales, where several stations had from 2 to 2½ ins. In the subsequent 24 hours the fall was generally very small, the only amounts at all worthy of mention were values of from ½in. to 1½ in. in the north-east of Scotland.

I applied to the Registrar-General's office for a return of the total number of deaths caused by the gale, but the reply stated that (except for London, where 8 deaths were ascribed to that cause) they had no information. The greatest loss was of course at sea, but even on land it was very considerable. I know that the list given in Appendix B (p. 11) is far from perfect, yet it contains 46 deaths and 40 accidents so serious as probably to add at least another 5, making in all 50 deaths, while cuts and minor injuries from tiles, slates, glass, &c., are of course innumerable.

A few general remarks on the practical bearing of the facts relating to damage by this storm seem necessary.

In the first place, the area over which injury was produced is very large, and although certainly such extensive injury is not without precedent, it is happily rare. The extent of a list of damage depends upon two conditions, on the amount of damage done, and on the amount of care taken in order

to collect the details. A mere comparison of one list with another list affords, therefore, no accurate means of comparison.

As regards local intensity we are not much better off; for as concerns anemometers, even if the same instrument has been kept in the same position for say half a century, he would be a bold man who asserted that its friction coefficient is the same now as when first erected. It may be thought that if a church spire was erected in 1880 and the top was blown off in 1881, it necessarily follows that the gale of 1881 exceeded all during the previous half century;—but before admitting that to be the case, very careful examination of the fracture must be made, in order to ascertain whether any considerable decay had taken place. Appendix C. (p. 12) contains a list of selected cases of structural damage.

Nor are personal impressions to be trusted, for most persons are aware that our impressions respecting the intensity of phenomena vary with age, vary with the lapse of time, and vary according to our subsequent experience.

Hence there is hardly any single piece of evidence which of itself could be accepted as settling the question of relative strength. Corroboration is indispensable, and it may come in any form; for instance, the record of the pressure of 58 lbs. per square foot at the Royal Observatory, Greenwich, is for that locality the highest ever recorded, and close by we have 85 trees blown down in the Park, and 15 ft. blown off the top of a spire which had been erected about 40 years, the stone of which shows no signs of decay, and which had retained its position, almost if not, wholly by the gravity of its mass.

The general opinion seems to be that the structural damage over the greater part of the country was not by any means unprecedented, and in the greater part of Ireland and the south-west of England was not even of an unusual character, but along the east coast and in the east Midlands the damage was excessive, while on the north-east coast it was unprecedented. Of Scotland it is difficult to speak, as, although the destruction of trees was enormous, few accounts of damage to buildings have reached me.

Over the whole of England, with the exception perhaps of the extreme south-west, slates, tiles and chimney-pots were dislodged in vast numbers, and are generally spoken of as flying about freely. Chimney stacks were thrown down and roofs partially destroyed, sparingly in the west and plentifully in the Midlands, with occasional gables, entire roofs and factory chimneys; in the east and north-east scarcely a town escaped without the destruction of numerous chimney stacks and entire roofs, some being lifted bodily, and more serious damage was frequent, such as the demolition of unfinished buildings and of parts of the walls of occupied houses, &c. Churches suffered considerably, great numbers of turrets and pinnacles being dislodged and frequently falling through the roofs; and the tops of many spires were twisted, displaced, or thrown down.

Considerably more than a dozen cases occurred of very serious damage, such as the entire destruction of occupied houses, but in most cases they were of the poorer description and probably old and dilapidated. Perhaps

the best illustrations of the excessive force of the wind are furnace chimneys and iron factory and wharf buildings, of the destruction of which there are many instances.

Conscious of the value of the data respecting the snowstorm of January 18th, furnished by the Railway Companies, I issued a short series of questions as to the damage done to their property to several of the largest companies.

Replies have been received from twelve companies, and an abstract of the data supplied is given in Appendix A (p. 10). In connection with the fall of signal-posts, as to which information was specially asked, it should not be forgotten that their age and condition, as also the manner in which they were "stayed," are material points to consider in connection with the force required for their overthrow.

The overthrow of trees is one of the indications of the force of a storm most readily accepted by the public. But it is, perhaps, the vaguest guide which one could suggest.

In the first place, the effect of wind upon trees is, so obviously that it seems superfluous to mention it, chiefly dependent on their state of leafage.

Secondly, there is the class of tree, which has three different influences: (a) the shape of trunk, branches, &c., e.g. a fir, and an oak; (b) the pliability or otherwise of the wood, the nature of the root hold—whether deep or superficial; and (c) lastly, there is the age of the trees.

Many trees in hedges, and in river banks, are yearly becoming liable to tumble down, the first time that a moderate breeze attacks them on their weak side, for all trees in hedges and river banks *have* a weak side, and if the direction of a gale be unusual, extra havoc will not necessarily prove that extra force has been exerted.

Again, the effect is partly proportional to the time which has elapsed since a previous storm—because if the interval be short, the previous storm may be assumed to have removed the frail ones, and therefore the havoc will be small; if the interval be long, many trees will have had time to grow weak and rotten, and the damage will appear excessive.

As regards soil, the effect is that of affording variable hold to the roots, and the overthrow of a dozen trees in one place, where the existence of a bed, of rock compels the roots to remain near the surface, may not indicate so much force as the overthrow of a single deeply rooted specimen. There is another condition of soil which should not be neglected, namely, the level of the subsoil water; the tenacity of the soil varying greatly with its hygroscopic state.

As regards the damage to trees I rely chiefly on the remarkable series of returns collected by the Editor of *The Journal of Forestry*, and filling seventeen pages of that periodical for November, 1881, with records of the damage wrought.

I reproduce the Editor's note upon the subject, giving further details in a tabular form in Appendix D (p. 14):—

"Such general and widespread destruction to trees and plantations in this

country as occurred on the 14th of October, is not on record; at least, we have failed to find any account of a former storm so terribly disastrous to trees in every part of the country. It is difficult to point to any district where the trees have not suffered severely from the gale; but its greatest strength appears to have been felt along the eastern coasts, and inland to the backbone of the country. In all districts with an eastern exposure the work of destruction is indeed lamentable. Hundreds or thousands of splendid trees, some historical, many ancestral, and all worthy of passing remark, have been overwhelmed in the general ruin, and centuries must elapse before the spots on which they stood can again be clothed and adorned with such grand monarchs of the forest."

APPENDIX A.—Return of Damage made by Railway Companies.

South Eastern.—No signal posts were destroyed, but an engine shed at Westerham was wrecked.

London, Chatham and Dover.—Three signal posts and about 20 telegraph poles were overturned on various portions of the line between London and Whitstable. The glass roof at the Main Line entrance to Victoria Station was almost destroyed, as far as glass and woodwork were concerned, and corrugated iron roofs were blown off a shed at Battersea and a platform at Herne Hill. So much damage had not been caused by wind in any previous gale.

London, Brighton and South Coast.—The only damage on this line was the destruction of some trees on the company's land, 5 elms near Leatherhead, and an oak at Horley. The trees were from 60 to 85 ft. high, and varied in diameter from 2 to 3½ ft.; they fell generally in a south-easterly direction, that at Horley lying in an easterly direction across the up and down lines.

London and South Western.—No serious damage was done on this company's system of lines.

Somerset and Dorset.—No damage reported to signals, telegraph posts, or sheds.

Great Western.—Signals were destroyed at 40 places and damaged at 5 others; the posts fell generally to the eastward, but in 4 cases, chiefly between Didcot and Swindon, they lay to the westward. At Highbridge the up-platform, measuring 75 ft. by 7 ft. and 4 ft. deep, was lifted a distance of 4 ft. on to the up line of rails; and at Hagley, in Worcestershire, a waiting shed was blown bodily away from the platform into an adjoining field and completely wrecked. A waiting shed was also blown down at Saltney, Cheshire, and two Paxton roofs, 13 ft. by 10 ft., were blown off the Paddington goods station. Skylights, windows, and roofs were destroyed or damaged at 29 other stations on various parts of the line.

London and North Western.—Fourteen signal-posts were blown down on various parts of the line, falling generally to the eastward. In the southern division the gale is described as of great severity, resulting in much damage to sheds and stations. At Deepfields an unloading-shed, 120 ft. by 22 ft., was blown down, and a waiting-shed on the up-platform, 30 ft. by 11 ft., was unroofed. In the other divisions of this system the damage done was not unusual in character or amount.

MIDLAND.—On this system 50 signal-posts were blown down.

GREAT NORTHERN.—Ten signal-posts were blown down, falling generally to the south-eastward, and the semaphore arms of 6 other posts were blown away. An engine-shed built of timber was totally wrecked at Edgeware; open waiting-sheds were destroyed at Ponton and Waltham; and corrugated iron roofs were partly blown off at Stroud Green, Mill Hill, and Claythorpe. A good deal of damage was also done to chimney-stacks and fencing at various places.

GREAT EASTERN.—The return from this company enumerates a total of 290 cases of more or less serious damage at different parts of their system. Signals were damaged at 69 stations. At Loughton the excursion platform was blown down; and new waiting-rooms and platform were damaged at Forncett. Level-crossings' gates were blown down or broken at Glemsford and at Marlesford, in Suffolk, and at Sedgeford, in Norfolk; a great deal of damage was done to roofs, brickwork, fencing, windows, &c., on all parts of this system.

MANCHESTER, SHEFFIELD AND LINCOLNSHIRE.—Five signal posts were blown down, generally falling to the south-eastward, besides 9 others which were blown out of position. Fourteen telegraph posts were also overturned, and 15 partially so, on this company's lines.

NORTH EASTERN.—Thirteen signal posts were blown down and the arms of 3 others damaged on the southern division of this system; 1 was blown down and 6 shifted on the Blyth and Tyne section; 10 were blown down on the Darlington section, and 1 at Tweedmouth. On the Blyth and Tyne section a good deal of injury was done to roofs and chimneys, and the northern end of the station at South Shields was moved about 3 inches.

A wooden engine shed at Sprouston, and the shed over the Tatham Street Depôt at Sunderland were blown down. On the Darlington section cottages were unroofed and a window blown in at South Bank; several roof principals of an engine shed in course of construction at Newport were blown down; part of a brick parapet was blown off the water tower at Saltburn; and a wooden engine shed 100 ft. by 30 ft. was blown in upon the engines at Carlin How, about 20 ft. of the roof falling in. A new brick cabin at Newport had 17 ft. of a wall 9 ft. high blown down, and at Tees Tilery a window of a wood cabin was blown out from the inside, on the opening of a door, and could not be found again although search was made for it. The damage to roofs, &c., throughout this section was very great.

APPENDIX B.—DEATHS AND INJURIES.

Deaths.		Severe Injuries.	
London	8	Greenwich	1
Tring	1	Huntingdon	2
Aylesbury	1	Wolverhampton	3
Leatherhead	1	Birmingham	2
Isle of Wight	1	Liverpool	4
Long Marston	1	Stockton	14
Chipping Norton	1	Monkwearmouth	1
Cambridge	1	Sunderland	1
Wisbeach	1	Jarrow	2
Bristol	2	Tyne Dock	1
Little Dean	1	Wallsend	3
West Bromwich	4	Newcastle	3

Deaths.		Severe Injuries.	
Bewdley	1	Mitford	1
Birmingham	5	Morpeth	1
Smethwick	1	Kingstown, Dublin	1
Liverpool	2		
Stockton	5		
Jarrow	2		
Wallsend	2		
Howdon	1		
Bedlington	2		
Morpeth	1		
Kingstown, Dublin	1		
	46		40

APPENDIX C.—Selected Cases of Structural Damage.

MIDDLESEX.—*Burlington Street, Regent Street.*—Roof taken off a public-house. *Charles Street, Goswell Road.*—Factory chimney blown down. *Shoreditch.*—Gable of goods station blown down.

SURREY.—*Sutton.*—A row of four shops which were in course of erection in the High-street, were blown down.

KENT.—*Sheerness.*—One side of some government workshops (under repair) was blown completely out. *Blackheath.*—About 18 ft. of the spire of St. Michael's church fell. *Eltham.*—Three or four feet of the stonework of the top of the steeple was turned round about 1 foot from its proper position.

SUSSEX.—*Hastings.*—The gable end of a house was blown in.

HANTS.—*Farnborough.*—The side wall of the new church (new and scarcely set) fell. *Portsmouth.*—Part of the glazed roof of the railway station was carried away. *Wootton Common, I. of W.*—Part of gable of brick-built house blown out, part of the roof having been first demolished.

HERTS.—*Wheathampstead.*—The north-east end of a recently-erected school, built of cut flints with a layer of bricks laid zigzag, was much damaged. *Harpenden.*—Spire of the parish church blown out of the perpendicular, and had to be supported by ropes. *Watford.*—At the London Orphan Asylum a massive window was blown out, and a door 2 inches thick was burst through, a part of it being carried 12 ft. off.

BEDFORD.—*Leighton Buzzard.*—A chimney stack 26 ft. high blown down; the roof of some outbuildings of the Wesleyan Chapel deposited whole in an adjoining garden. *Kempsford.*—A pinnacle of the Church blown down.

DERBYSHIRE.—*Ilkeston.*—Piece of lead weighing more than 1 cwt. blown off roof of house.

OXFORD.—*Oxford.*—At the Divinity Schools at the five-order tower (now re-building), about four feet of new work was thrown down *Banbury.*—The Midland Horticultural Building Works, near the L. and N. W. station, were blown down.

NORTHAMPTON.—*Kettering.*—A corrugated iron roof, with the rafters, was torn off. *Peterboro'.*—A spire of the Parish Church was blown down.

HUNTINGDON.—*Huntingdon.*—The tall shaft at the Winnovers Carriage Works was blown down.

CAMBRIDGE.—*Cambridge.*—Part of a house blown down.

ESSEX.—*Romford.*—At Messrs. Ind, Coope & Co.'s brewery a shed, 160 ft. by 25 ft., supported by nine iron pillars, was blown over and carried several feet. *Southend.*—Part of the gables of two cottages forced in.

SUFFOLK.—*Ipswich.*—Part of a house blown in. *Bury St. Edmunds.*—New shaft snapped off about 8 ft. from the ground. *Lowestoft.*—A large chimney stack and a stone parapet were blown down.

NORFOLK.—*Hunstanton.*—Several gables were destroyed.

WILTS.—*Salisbury.*—Side of a house blown down.

DEVON.—*Ilfracombe.*—A block of buildings in course of erection was demolished.

GLOUCESTER.—*Bristol.*—About 12 ft. of the civic cross in College-green was blown off. *Gloucester.*—Iron roof of a shed at the docks lifted bodily from its supports.

HEREFORD.—*Hereford.*—About 3 cwt. of lead blown from the tower of All Saints' Church.

STAFFORD.—*Tamworth.*—Some strong brick buildings, with 9-inch walls, two storeys high, had the walls blown in. *Burton-on-Trent.*—A malt-house was blown down. *West Bromwich.*—A chimney stack, 150 ft. high, fell.

WORCESTER.—*Malvern.*—A great many roofs damaged.

WARWICK.—*Birmingham.*—The chimney of a house in Ingleby-street fell through the roof, and shortly afterwards the walls gave way. At Messrs. Salter's works a stack 130 ft. high was blown down. *West Bromwich.*—A stack 150 ft. high was blown down.

LEICESTER.—*Leicester.*—A chimney stack 80 ft. high fell. *Loughborough.*—At Messrs. Coltman's foundry a building with 9-inch walls, and an open roof supported by girders, was demolished.

LINCOLN.—*Algarkirk.*—Gable end of house demolished. *Holbeach.*—Newly-erected mill blown down. *Skegness.*—A large chimney stack fell, and a newly-built house had its roof torn off and part of the wall blown in. *Spalding.*—Mill chimney 50 ft. high fell. *Lincoln.*—St. Benedict Church partially unroofed, and 180 feet of brick wall blown down.

CHESHIRE.—*Weston.*—A house was blown down. *Seacombe.*—A chimney 150 ft. high, at the phospho-guano works, fell.

LANCASHIRE.—*Oldham.*—Several cottages and a chapel partly destroyed. *Burnley.*—A stone building in Brown-street was blown down. *Bolton.*—Two new stone houses, complete except the slates, were demolished, except one gable. *Blackpool.*—Several walls of houses in course of erection blown down. *Blackburn.*—Two sets of houses in course of erection blown down. *Liverpool.*—A building in course of erection in Upper Hamilton-street fell.

YORKSHIRE.—*Scarborough.*—A house blown down. *Guisborough.*—Chapel steeple blown down. *Selby.*—In the neighbourhood of the shipyard an inhabited house was completely blown down, and the gable end of another blown out. *Whitby.*—St. Hilda's Iron Church, West Cliff, a spacious building erected about twelve years ago, was blown down, and is a complete ruin, nothing but the porch being left standing.

DURHAM.—*Stockton.*—At Messrs. Smith & Stoker's works the wind totally destroyed half the foundry, the fitting shop, the pattern shop, the brass foundry, the locomotive engine-house, and the store room. The works were only erected about two years ago; they were substantially built, but were in an exposed position. *South Shields.*—A new house in Vicarage-street, consisting of two flats, was blown down. *Gateshead.*—In Church-street the gable end of a building was blown down, and also the gable end of Handyside's Hall, High-street. *Monkwearmouth.*—A steam tram-car was blown over; a cab was blown from Roker-avenue into a field at the side; the Propeller Inn, Low-street, had the gable blown in, and two houses had the upper storeys demolished. *Jarrow.*—A house in course of construction at Buddle Street was blown over.

NORTHUMBERLAND.—*Morpeth.*—Gable of a house fell. *Tynemouth.*—A tram-car was blown over at Washington-terrace. *Howdon.*—A house was partly blown down. *Wallsend.*—At the works of the Wallsend Shipway Company 80 ft. of the brick wall of a new boiler house, in course of erection, was blown down; the wall was 34 ft. high. *Blyth.*—A house in Bridge-street was partly blown down.

BERWICKSHIRE.—*Chirnside.*—The roof of a church was torn off; "the wood and

slates knocking down a turret, the stones composing which, weighing 1 cwt. each, were carried into a neighbouring garden."

CARNARVON.—*Carnarvon.*—Tower blown down.

ISLE OF MAN.—*Peel.*—Large unfinished building blown down.

DUBLIN.—*Dublin.*—A house at the corner of Liffey-street fell. A house in Patrick-street fell down, and another in New Market-street.

APPENDIX D.—DAMAGE DONE TO TREES.

(Chiefly abstracted from the *Journal of Forestry.*)

MIDDLESEX.—*Roy. Botanic Gardens, Regent's Park.*—More severe gales are remembered, but not so much damage to trees. *Hampton Court.*—Terrible havoc, some 60 or more fine trees are down—often 5 or 6 together. More damage than in any storm for 30 years. *Syon House.*—About 30 trees down and as many more injured. *Stanwell Place, Staines.*—Upwards of 50 trees down.

SURREY.—At *Chertsey*, *Croydon*, and *Dorking* the roads were blocked for some hours by fallen trees. *Ashley Park, Walton.*—About 40 large trees down. *Mount Felix, Walton.*—26 trees uprooted, or broken short off; one fell across a road and killed a boy. *Bagshot Park.*—A large number of elms and other trees uprooted. *Kingston.*—A row of 15 large elms torn up bodily, displacing an enormous quantity of earth; one mass of soil was 15 ft. wide and 9 ft. high, and two trees, which fell almost simultaneously, tore up a mass of earth measuring 28 ft. by 12 ft.

KENT.—*Greenwich Park.*—The (as far as is known) unprecedented number of 35 trees was blown down in the park, no fewer than 23 of which were large trees.

SUSSEX.—*Uckfield.*—The damage in this district was inconsiderable.

HAMPSHIRE.—*Fareham.*—Not much damage. *New Forest.*—Damage not serious.

BERKSHIRE.—*Windsor Park.*—Altogether 2,008 trees are seriously damaged, 961 being blown down.

HERTFORD.—*Bassingbourne.*—33 poplars blown down. *Tring Park.*—About 100 trees torn up. *Ashridge Park, Tring.*—About 200 trees torn up or seriously damaged. *Watford.*—There has not been so great a destruction of trees in this neighbourhood for very many years; 79 trees blown down at *The Grove; 56* at *Langleybury;* and a very large number in *Cashiobury Park;* 14 large trees were blown down in grounds around *Dalton House*, and 30 or 40 large ones in *Munden Park. Rickmansworth.*—A row of 11 large poplars blown down; many trees down in Moor Park.

BUCKS.—*Langley Park.*—Many trees damaged; one writer says that the woods looked as if they had been subjected to a heavy artillery fire. *Mentmore.*—From 50 to 60 large trees down, mostly elms, roads impassable for hours, no such hurricane known here for many years. *Long Marston, Aylesbury.*—Many elms down.

BEDFORD.—*Old Warden, Biggleswade.*—Gale very severe, many fine trees uprooted, and the park quite a scene of desolation. *Woburn Abbey.*—Some hundred of trees torn up by the roots.

CAMBRIDGE.—*Wimpole.*—Unprecedented destruction of trees.

SUFFOLK.—*Sudbourne Hall, Wickham Market.*—Nearly 100 trees are down on this estate, many of them fine healthy oaks, aged 50 to 70 years. *Campsey Ashe, Wickham Market.*—Many trees here have had their heads twisted quite round, the stumps being left in the ground. *Ufford, Woodbridge.*—About 80 fine poplars are down.

NORFOLK.—*Wroxham Hall, Norwich.*—No such damage since May 1860, hundreds of trees are down, and hundreds more are terribly mutilated; roads much blocked.

DORSET.—*Milton Abbey, Blandford.*—Not many trees blown down, but a great many are seriously injured.

GLOUCESTER.—*Woodchester Park, Stonehouse.*—Trees uprooted 15, damaged 75.

HEREFORD.—Round *Leominster, Bodenham*, and *Whitfield* trees and plantations have suffered very greatly.

SALOP.—*Weston Park, Shifnal.*—Very severe gale,—600 trees are down on this estate, and nearly as many more are disfigured. *Willey* and *Dothill, Bridgenorth.*—The damage here is extraordinary, especially in noblemen's parks, and in the valleys. Trees on high ground not seriously injured. About 2,000 trees have been uprooted in this district. *Stanley Park, Bridgenorth.*—Upwards of 100 trees down.

STAFFORD.—*Blithfield, Rugeley.*—The destruction of timber fearful, trees coming down in all directions, 1,000 estimated to be down on this estate; one plantation was quite wrecked, more than 300 trees going down. *Alton Towers, Stoke.*—More than 300 trees down; it is years since, if ever, we had such a storm. *Tamworth.*—Within a radius of a few miles thousands of trees are uprooted or broken.

WARWICK.—*Coventry.*—Many of the turnpikes are impassable from the nnmber of fallen trees; upwards of 500 full grown ones are down within 3 miles of the town.

LEICESTER.—*Ashby-de-la-Zouch.*—Hundreds of trees uprooted.

NOTTS.—*Thoresby Park, Ollerton.*—Our trees are terribly mutilated, and 195 are down. *Welbeck, Worksop.*—Total number of trees down 939, but they had not good foothold. *Clumber* and *Worksop Manor.*—Total trees down about 500; 65 were chestnuts about 35 years old and all within a space of about 2 acres.

LANCASHIRE.—*Norris Green, Liverpool.*—Violent wind, 7 or 8 trees uprooted. *Rufford Hall, Ormskirk.*—12 trees down, and many more damaged; we have not had so much injury to timber since September, 1875. *Wyreside.*—Very little damage here or in North Lancashire.

YORKSHIRE.—*Wortley Hall, Sheffield.*—Damage only slight. *Owston Park, Doncaster.*—Gale very severe, rather more than 100 trees down or broken. *Beningborough Hall, York.*—Very severe gale, many trees down. *Birdsall, Malton.*—3 of the splendid limes, 80 to 100 ft. high, blown over. *Newton, Rillington, Malton.*—Great damage, about 600 trees are down. One plantation of larch, about 25 years old, had a lane about 20 yards wide and 100 yards long made through it, in which nearly every tree is down. *Park Hill, Fylingdale, Whitby.*—Very heavy gale, farm buildings much damaged, and 495 trees (mostly small) blown down. *Loftus, Cleveland.*—Great damage, 1,030 trees uprooted, and many more damaged. *Upleatham, Redcar.*—About 1,390 trees are uprooted on this estate, and other estates in the neighbourhood have suffered severely.

DURHAM.—*Gateshead.*—Considerable damage but not many trees down.

NORTHUMBERLAND.—*Alnwick Castle.*—About 4,200 trees are down here, mostly large ones. Lanes were ploughed through the plantations in straight lines. *Morpeth.*—Trees by the hundred have been uprooted or snapped, and the roads to the E, W and N of the town are blocked.

CUMBERLAND.—*Keswick.*—Very little damage. *Penrith.*—Very few trees injured.

WESTMORELAND.—*Kendal.*—A good many trees damaged. *Ambleside.*—Trees much damaged.

CARMARTHENSHIRE.—*Hafodunos.*—Greater destruction than for forty years. No trees down before 7 a.m. 14th. Subsequently many large ones overthrown or broken short off. Several of the plantations have paths 20 or 30 ft. wide swept right through them; and in a few hours as many as 1,500 young trees went down, mostly larch. *Llanerch, Llanelly.*—In our sheltered valleys the damage done proves less than we expected; of course many trees are injured, but the number overthrown is perhaps one in each two acres.

MONTGOMERY.—*Churchstoke.*—Trees much damaged.

DENBIGH.—*Bodnant.*—About 60 large trees uprooted. *Kinmel Park, Abergele.*—The plantations have nearly escaped, not more than about 200 trees being down; but the destruction of ornamental park trees and of hedge-

row trees has been great. Nearly every other tree in the park is more or less damaged.

CARNARVON.—*Penrhyn Castle, Bangor.*—A great many trees uprooted and seriously damaged. All hands have been required to clear the roads and drives; damage to the plantations not yet ascertained.

DUMFRIES.—*Jardine Hall, Lockerbie.*—Very little damage. *Drumlanrig.*—Storm not severe here.

ROXBURGH.—*Floors Castle, Kelso.*—This district has suffered severely; within four miles of the town at least 3,000 large trees are down. We have had more damage done to buildings by previous storms, but never so much to trees. This is due to several circumstances: the trees were in leaf, the ground was very wet, and the gale came from an unusual direction—N.N.E. At least 800 of the finest trees on this estate are down, and 200 more are so disfigured that they must be removed. *Bowmont Forest, Kelso.*—A tract of from 4 to 5 acres, covered with Scotch firs about 80 year old, is swept clear. *Jedburgh*—No such ruin of trees since 1839.

PEEBLES.—*Portmore, Eddlestone.*—Very little damage.

BERWICK.—*Dunse*—Within 3 or 4 miles many thousands of trees are uprooted, the roads are blocked in all directions; sometimes one finds 20 large trees across a road within half a mile. A beautiful avenue of lime trees at Dunse Castle has been wrecked. The trees, which were of great size and remarkably equal in proportions, lined the upper part of the approach to the Castle from Dunse. Dunse Castle Loch lies to the north-east of the avenue, having wooded slopes to the north and Duns Law on the south. Through this opening over the lake the storm seems to have played as through a funnel, striking the avenue about its centre, and uprooting on the east side of the road fourteen trees of immense size which had braved the storms of centuries. *Langton, Dunse.*—No such hurricane is remembered here; we have at least 5,000 trees down; we have lost one clump of 60 magnificent beeches, and on the turnpike roads traffic is impossible. Some adjacent estates have suffered even more than we have, for some have had one-third of their trees blown over. *Luchie House.*—Upwards of 1,000 large trees down. *Greenlaw.*—Several thorn hedges were torn up here—a fact almost without precedent.

HADDINGTON.—*Broxmouth.*—The damage is indescribable; whole acres of oaks, beeches and elms are blown down. *Whittinghame.*—Although we have not suffered so much as our neighbours, the damage exceeds that of any gale remembered by any one on the estate. Many large trees are down, and about 500 in the plantations. *Tynninghame, Whitekirk.*— The gale came like a thunderbolt, and lasted two hours; the atmosphere was literally filled with leaves, twigs, and branches. The number of trees blown down cannot be less than from 30,000 to 40,000.

EDINBURGH.—*Dalkeith Park.*—Great damage, at least 150 large trees down, mostly in patches; for instance, at one place there are six large trees all in a heap, and at another spot half-a-mile away, there are a dozen Spanish Chestnuts all down together.

LINLITHGOW.—*Hopetown.*—Very little damage here, not more than 30 trees down.

DUMBARTON.—*Alexandria.*—Not much damage here, but a few trees down at *Roseneath Castle.*

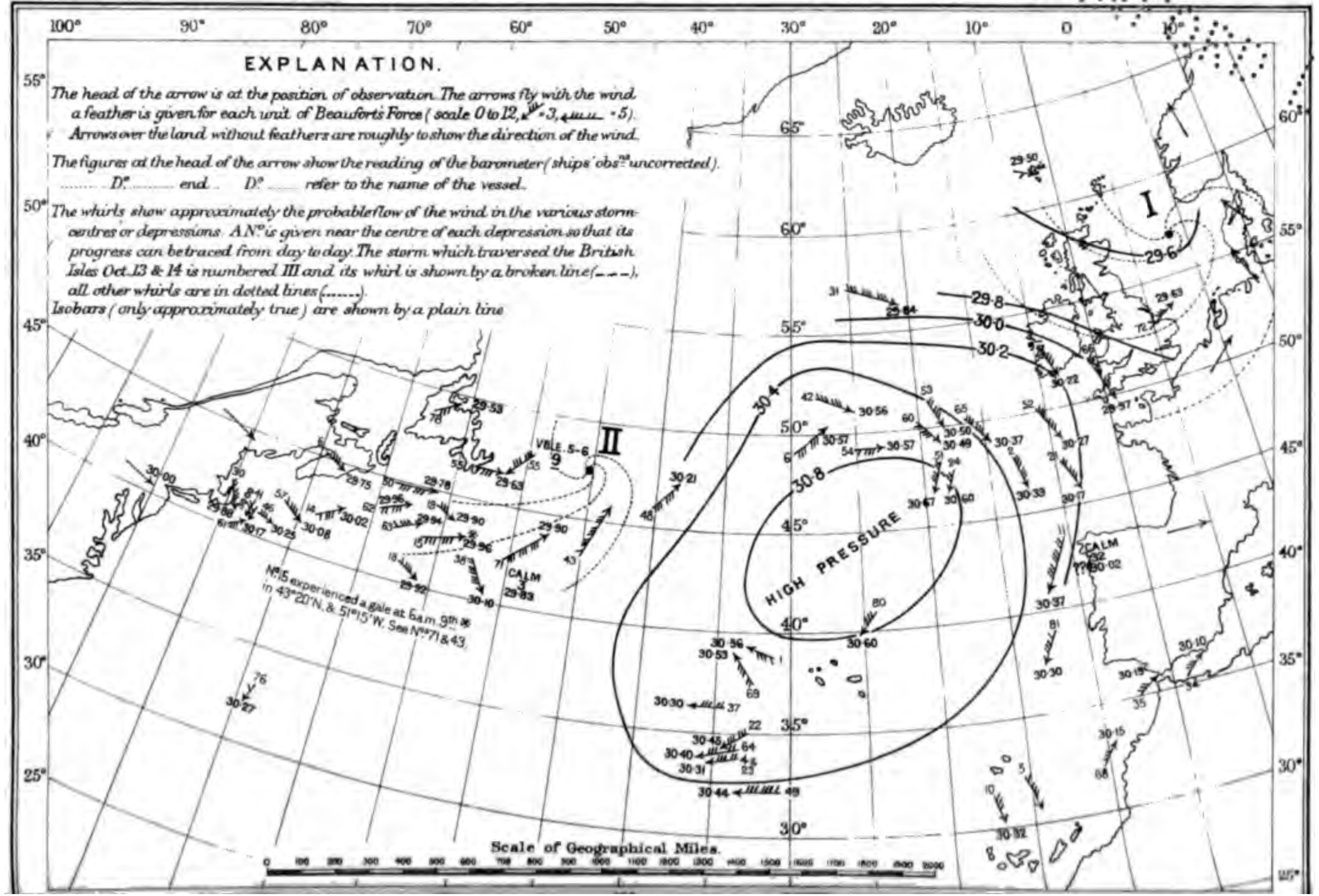
STIRLING.—*Rednock.*—Very little damage.

BUTE.—*Rothesay.*—Little damage.

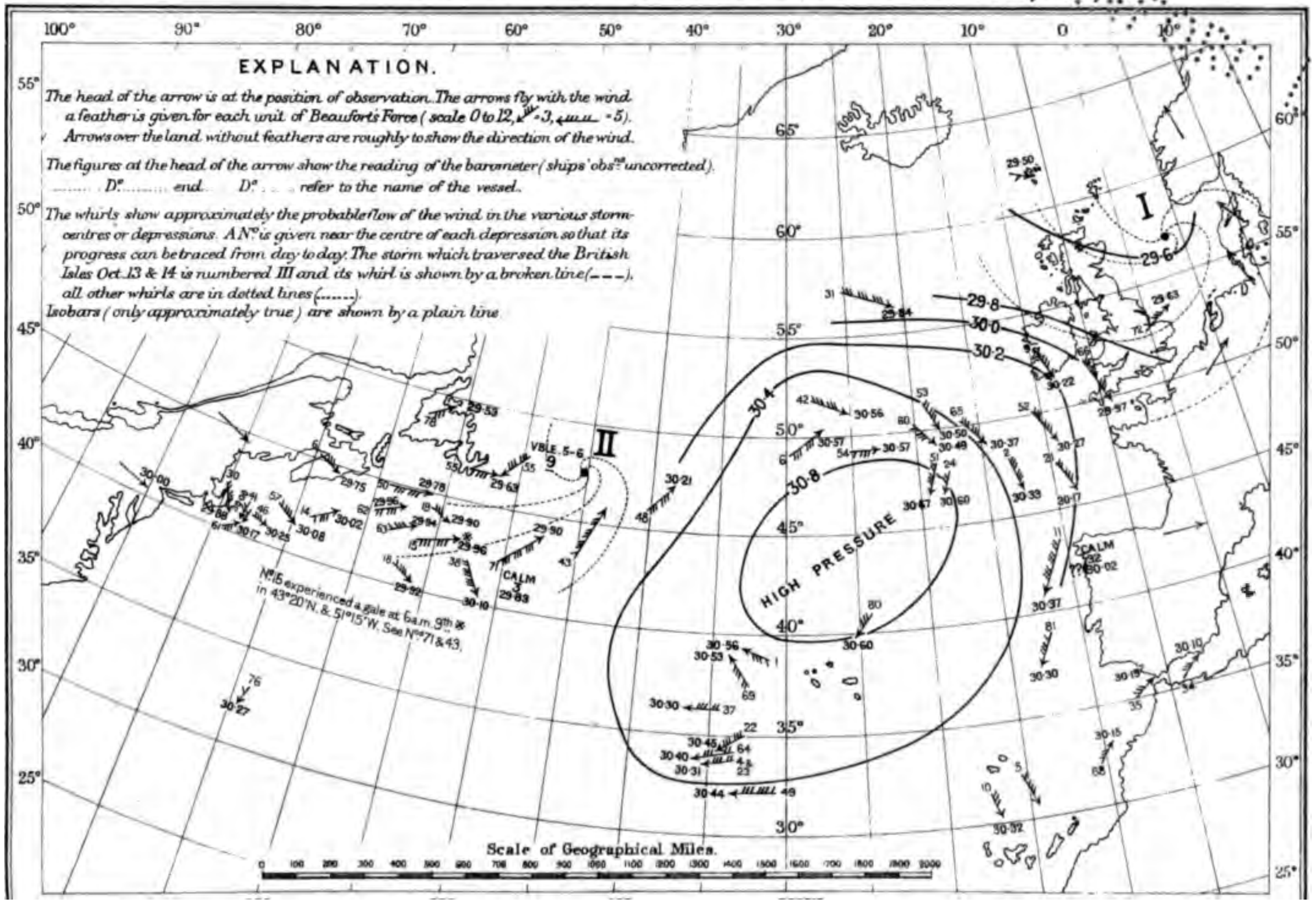
FIFE.—*Donibristle, Aberdour.*—Although we have not suffered so much as others, I never saw such havoc before. Our drives were literally covered with branches, and we must have about 250 trees down.

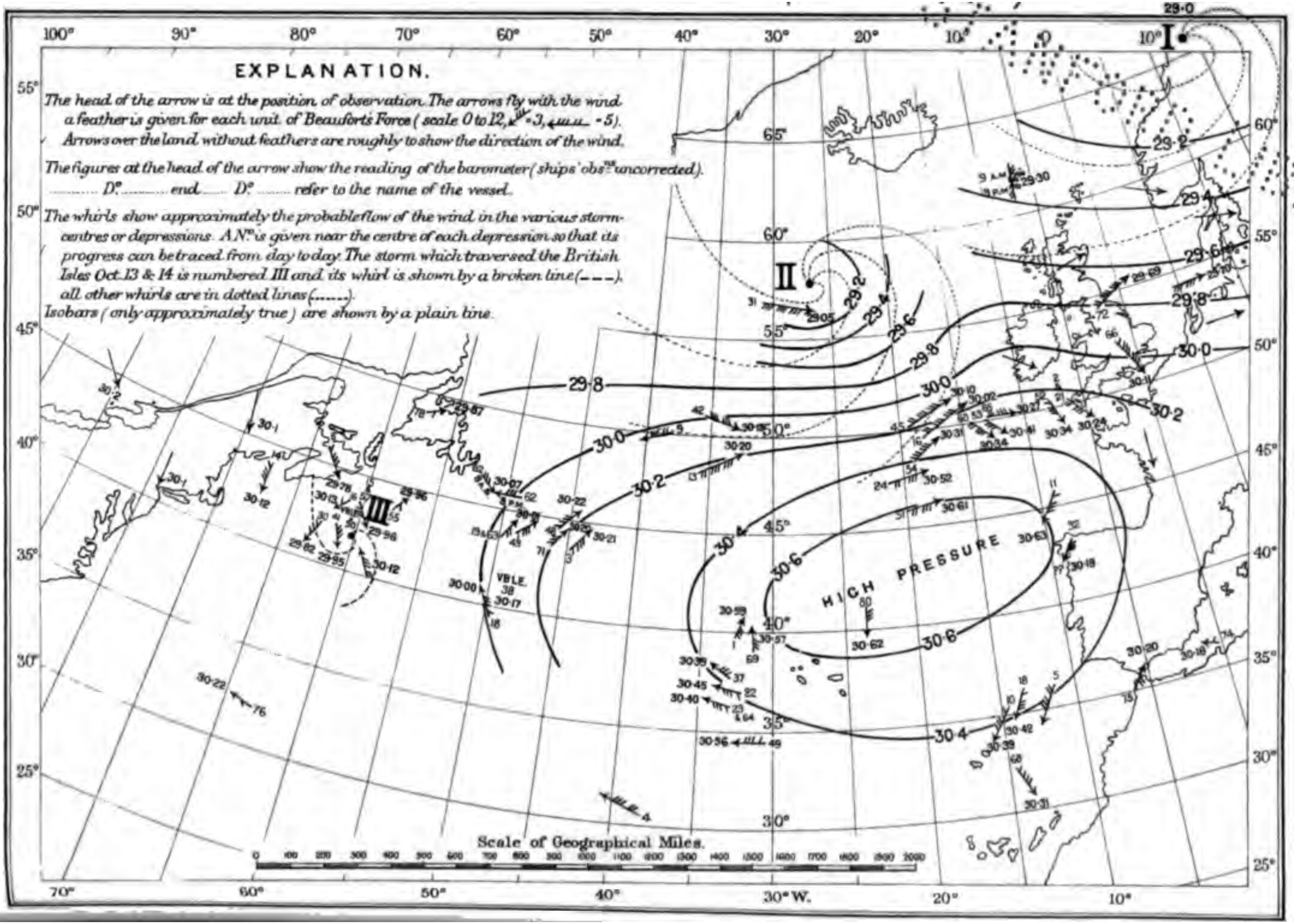
PERTH.—*Alyth.*—In the woods the destruction is serious. In the woods of *Bamff*, great lanes are opened through the thickets, and in the wood of Loyal trees are down in clumps. At *Balloch*, *Buchal*, *Balhary*, and *Johnshill*, trees of great age and of all kinds are prostrate. *Murthly Castle.*—At 9.30 a.m., a terrific wave not lasting more than $1\frac{1}{2}$ minutes, about $1\frac{3}{4}$ miles broad, swept from NE to SW, the noise was indescribable, and the

9TH OCTOBER 1881 – NOON (LOCAL TIME)

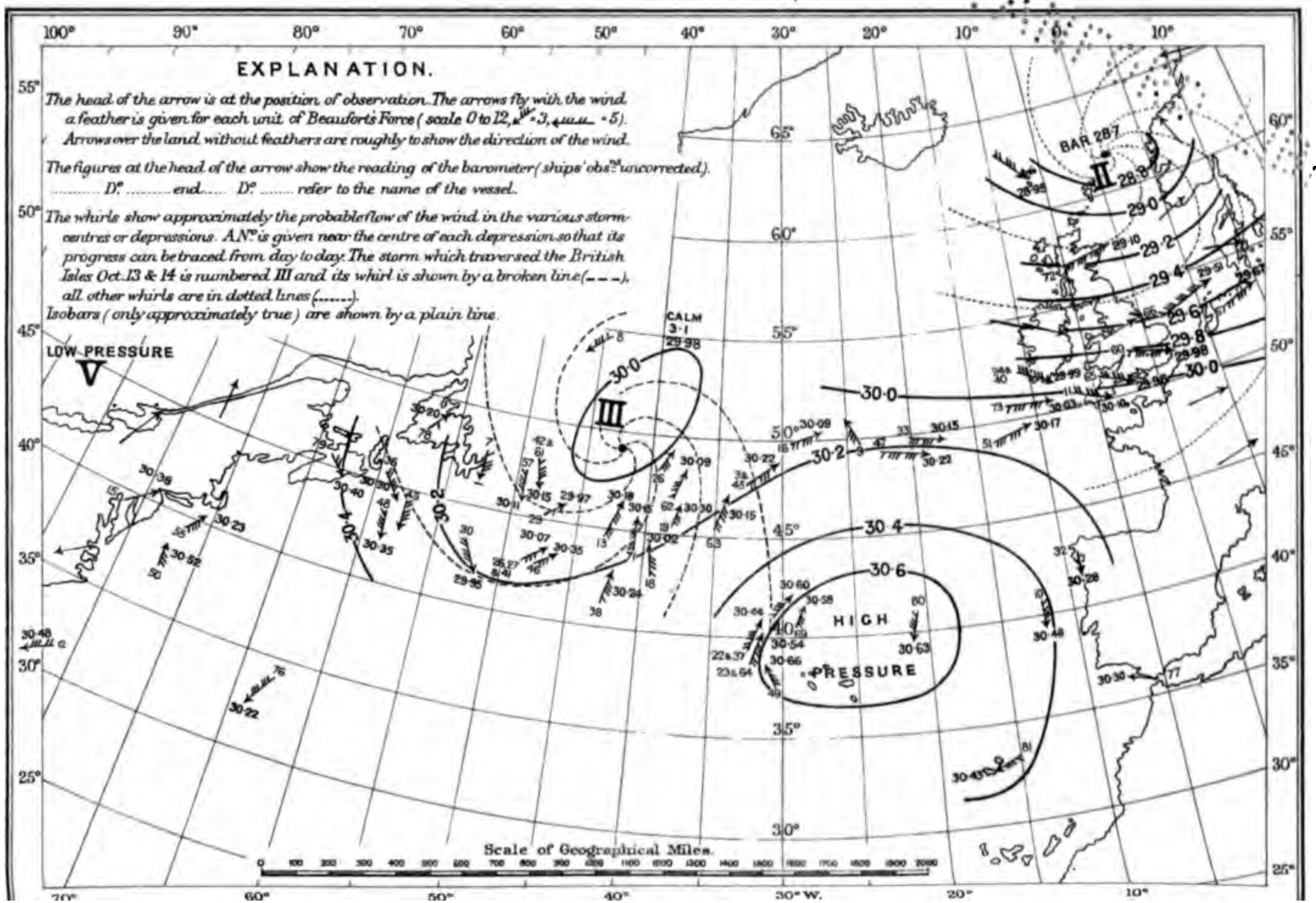


9TH OCTOBER 1881 – NOON (LOCAL TIME)

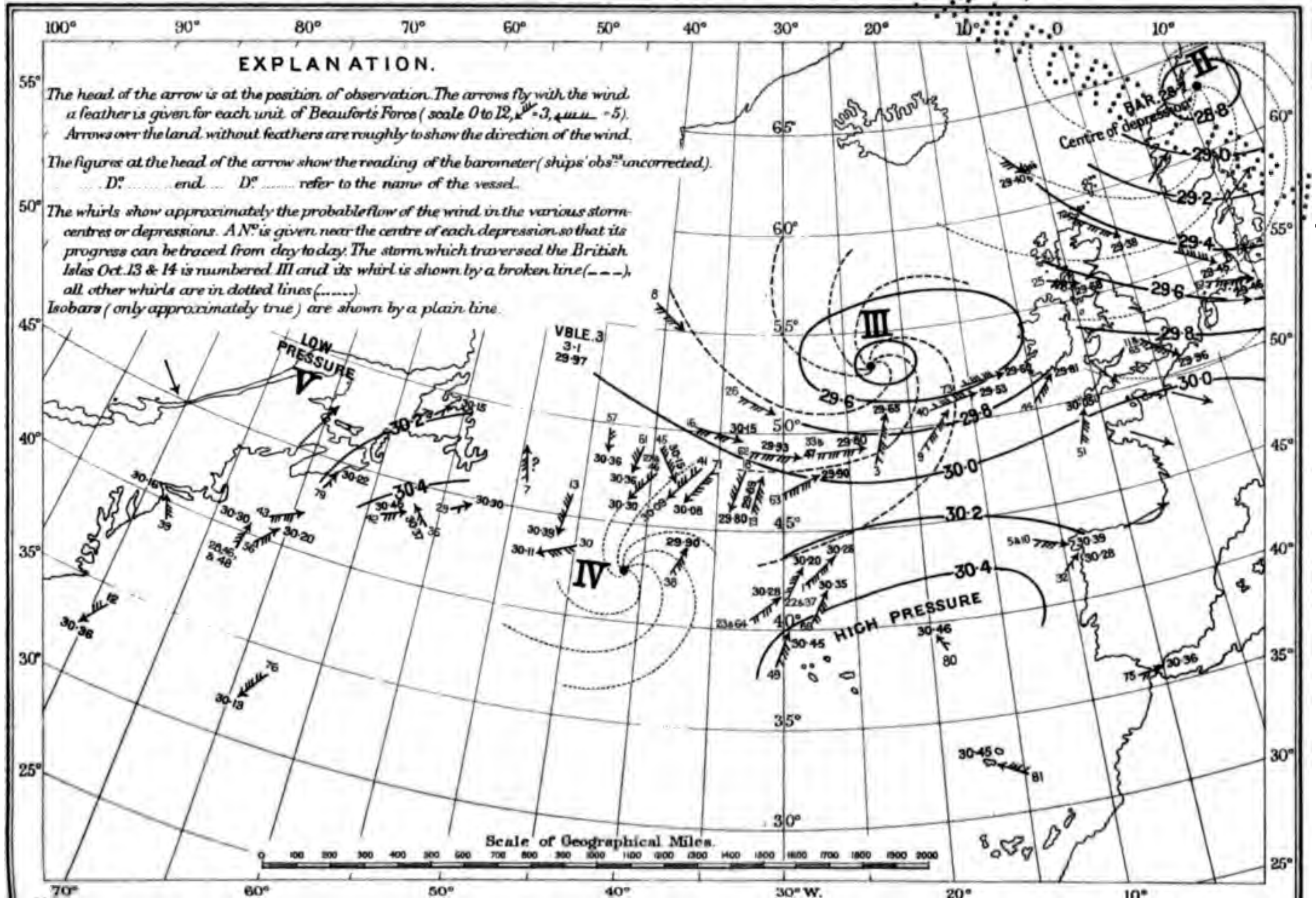



EXPLANATION.
The head of the arrow is at the position of observation. The arrows fly with the wind, a feather is given for each unit of Beaufort's Force (scale 0 to 12, = 3, = 5). Arrows over the land without feathers are roughly to show the direction of the wind.
The figures at the head of the arrow show the reading of the barometer (ships' obs.ns uncorrected). .... D°. .... end .... D°. .... refer to the name of the vessel.
The whirls show approximately the probable flow of the wind in the various storm-centres or depressions. A N°. is given near the centre of each depression so that its progress can be traced from day to day. The storm which traversed the British Isles Oct. 13 & 14 is numbered III and its whirl is shown by a broken line (- - -), all other whirls are in dotted lines (......).
Isobars (only approximately true) are shown by a plain line.
HIGH PRESSURE
Scale of Geographical Miles.
30° W.

12TH OCTOBER 1881 – NOON (LOCAL TIME.)



13th OCTOBER 1881 – NOON (LOCAL TIME).



14TH OCTOBER 1881 – NOON (LOCAL TIME).

damage excessive. Have not ascertained the number of trees down, but certainly several hundred. *Scone.*—On this, and Lord Mansfield's other Perthshire estates, upwards of 2,500 trees are down, mostly spruce and larch, aged about 50 years.

FORFAR.—*Strathisla.*—A few hundred firs are down, but the damage is not equal to that in the Tay Bridge storm. *Glamis.*—Although on some neighbouring estates the damage far exceeds that in the Tay Bridge storm, we have not suffered one-sixth as much as we did then.—*Strathmore.*—About 1,500 trees down. *Panmure.*—We have about 900 trees down, against 150 in the Tay Bridge storm.

ABERDEEN.—*Aboyne.*—Scarcely any damage. *Keith Hall.*—Very little damage.

BANFF.—*Cullen House.*—Heavy gale, but only a few trees down.

MORAY.—*Altyre.*—Very little damage; not more than 3 dozen trees down in the whole estate.

NAIRN.—*Nairn.*—No damage.

INVERNESS.—*Corrimony.*—Not more than 40 trees down.

WATERFORD.—*Curraghmore.*—Some of our higher plantations were wrecked; altogether we have 1,300 trees down.

DUBLIN.—*Dublin.*—Many trees either torn up by the roots or stripped of their branches.

CAVAN.—*Farnham.*—Very little damage.

ROSCOMMON.—*Roscommon.*—No such gale since January, 1839, many trees down.

ARMAGH.—*Loughgall.*—Cannot give total number of trees down, but the damage has been serious.

ANTRIM.—*Antrim.*—Gale very heavy here, far greater than in the Tay Bridge storm, and a great many trees uprooted.

HISTORY OF THE GALE OF OCTOBER 13TH AND 14TH, 1881, OVER THE ATLANTIC OCEAN AND ON THE COASTS OF THE UNITED KINGDOM. By CHARLES HARDING, F.M.S. (Plates III. to VIII.)

[Read November 16th, 1881.]

UPON the receipt of Mr. Symons' circular, asking for information respecting the storm of October 13th and 14th, it occurred to me that information obtained from vessels at sea would throw light upon the track of the storm and upon the damage done to shipping on our coasts, and that this supplementary paper would be acceptable to the Society.

The Meteorological Council has kindly afforded me every facility in obtaining information, and has placed its valuable records at my disposal for the preparation of this paper. The leading Shipping Companies, and others, have also in the most ready manner rendered material assistance.

In one sense the discussion of the weather in the Atlantic has not proved as interesting as might have been expected, since the storm did not blow with violence at any very great distance from our shores; indeed, in the immediate proximity to our western coasts the gale was of no unusual strength. Copies of the logs from upwards of 100 vessels have been received for the northern part of the North Atlantic, and of these only a very few experienced the gale.

The German Steam-ship 'Salier' (No. 62), homeward bound from

America, was overtaken by the gale at about midnight of the 12th in 48° 45′ N and 32° 15′ W, about 850 miles from the Irish coast. The force, however, does not appear to have exceeded 8 (a fresh gale), and the fall of the barometer was but slight; the lowest reading noted was 29·8 ins. (This is the westernmost evidence we have of the gale, except near the American coast on the 11th.)

The Anchor Line Steam-ship 'Bolivia' (No. 38), outward bound to America, met the gale at noon on the 13th, about 500 miles to the WSW of Valencia (Ireland). She did not experience a stronger force than a fresh gale, and her lowest barometer reading was 29·80 ins.

The Anchor Line Steam-ship 'Alsatia' (No. 47), also outward bound to America, met the gale under very similar conditions to those given above for the 'Bolivia,' and her lowest barometer was also 29·80 ins.

The Cunard Steam-ship 'Algeria' (No. 8), homeward bound from America, was overtaken by the gale (W 8) at 6 p.m. on the 13th, in 50° 30′ N and 20° W, about 380 miles from the Irish coast; the strongest force with her was 9 (strong gale) from WNW, barometer 29·50 ins. She speaks of violent squalls with the north-westerly wind. The gale had passed to the eastward of this vessel by 4 a.m. on the 14th.

The White Star Steam-ship 'Republic' (No. 40), outward bound to America, met the gale in the latter part of the 13th, between 200 and 300 miles from the Irish coast; she experienced the strongest wind (force 9) from the NW at 1 a.m. on the 14th in 51° 20′ N and 18° W.

The Montreal Ocean Steam-ship 'Sarmatian' (No. 9), homeward bound from America, was overtaken by the gale on the afternoon of the 13th, and experienced the worst of the gale (force 10) on that day in about 51° 20′ N and 13° W, about 120 miles from the Irish coast. She lost her maintopsail, and speaks of violent squalls with the NW wind.

The Steam-ship 'Thames' (No. 73), outward bound to Quebec, had no indication of a gale at 6 a.m. 13th, wind calm, but shortly afterwards the barometer fell briskly, and she first experienced a fresh gale (force 8) from SWbW at 4 p.m. in 52° N and 12° 30′ W, about 80 miles from the Irish coast, the lowest barometer was 29·90 ins. at midnight in about 52° 10′ N and 13° W, and the force reached that of a storm (force 11) from the NW, in the early morning of the 14th, weather very squally.

The Cunard Steam-ship 'Marathon' (No. 44), outward bound to America, left Queenstown at 2h. 42m. p.m. on the 13th; at 4 p.m. she only had a moderate wind from the W, and first met the gale at 8 p.m.

The Inman Steam-ship 'City of Rome' (No. 70), outward bound to America (on her first passage), passed the S. Stack at 8h. 51m. p.m., and at that time records a fresh westerly gale.

Charts have been drawn for noon each day from October 9th to 14th, showing the wind, direction and force, and reading of barometer over the northern part of the North Atlantic.

Although the *storm* cannot be traced far out into the Atlantic, yet the "*system*" to which the storm belonged can be traced with a fair amount of

certainty right across the Atlantic (*see* Storm-centre III. on Plates IV. to VIII.)*

In deciding the position of the centre of disturbance for the respective days on its passage across the Atlantic, the observations on the Charts alone have been used in the first place, but as a check upon this the actual changes of wind experienced by the several vessels, as they met and passed through the system, have been considered. The Charts give the position of the centre of disturbance at noon, for the storm which struck our islands on October 13th and 14th as follows:—

	Lat.		Long.	
10th	41° 30′	N	60°	W
11th	42	,,	54	,,
12th	49	,,	42° 30′	,,
13th	53	,,	23	,,
14th	56	,,	1	E

So that it appears that the system travelled at the following average rates across the Atlantic:—

Noon 10th	to	Noon 11th	... 12	miles per hour.
,, 11th	,,	12th	... 26	,,
,, 12th	,,	13th	... 34	,,
,, 13th	,,	14th	... 39	,,

The miles are geographical or nautical miles, and in calculating the hourly rate of progress allowance has been made for the Charts showing local time, so that the actual rate per hour is given.

Observations from a vessel or two making the northern passage on the eastern side of the Atlantic would add materially to the value of the Chart for the 13th, so as to give some clue as to what was going on to the north of the centre of disturbance. The information already collected is, however, sufficient to prove that the system to which the storm belonged developed energy very suddenly when approaching our coasts—the reading of the barometer near the centre of the storm being very considerably lower when the storm passed over the British Islands than when it was out in the Atlantic. It is of interest to notice the influence of the passage of this storm on the area of high barometric pressure which existed to the north of the Azores. The Charts for the 9th to 12th show a reading of 30·6 ins.; but as the storm passed to the northward this reading was lowered to the extent of about two-tenths of an inch.

This Paper does not deal with the storm when it was situated over the British Islands, since that part of the discussion is dealt with in Mr. Symons' Paper.

As far as the sea is concerned the chief force of this gale was felt in the

* This storm has also been discussed by Dr. J. van Bebber, and published in 'Annalen der Hydrographie und Maritimen Meteorologie,' Heft I. (Januar), 1882. Dr. van Bebber chiefly deals with the storm over the land, and traces it as far as the White Sea on Oct. 18th.

German Ocean, but there the character of the gale was peculiar, since the front of the storm was not fully developed, owing to the gale which had but just passed to the eastward; the rear of the storm was, however, exceptionally violent, and was accompanied by particularly violent squalls, to which probably the great loss of life and destruction to shipping is mainly due. The sudden nature of the storm may be gathered from Sir Thomas Brassey's account of his experience of this storm on board the 'Sunbeam.' This vessel was off Whitby at noon on the 14th, the wind blowing strongly but not with the force of a gale. At 2 p.m. the barometer had fallen to 28·45 ins. Sir Thomas Brassey remarks: "No further incidents occurred until 8 p.m., when we were nearing Flamborough Head. Here we were at last overtaken by the long-impending storm. Looking back to the north-west, over the starboard quarter, we saw that the sea had suddenly been lashed into a mass of white foam. The hurricane was rushing forward with a velocity and a force which must have seemed terrible to the fleet of coasting vessels around us. Before the gale struck the 'Sunbeam' our canvas had been reduced to main and mizen trysails and reefed standing-jib; but even with this small spread of sail, and luffed up close to the wind, our powerful little vessel careened over to the fury of the blast until the lee-rail completely disappeared under water—an incident which had never previously occurred during all the extensive voyages we had undertaken. Such was the force of the wind that every sailing vessel near us lost all her sails, and our large gig was stove-in from the tremendous pressure of the gunwale against the davits. . . . .

"For an hour and a-half we lay-to on the starboard tack standing in for the land below Bridlington Bay. . . . The fury of the wind so filled the air with spoon-drift that we could not see a ship's length ahead. . . . At 9 p.m. the extreme violence of the hurricane had abated."

A similar description is also to be gathered from an extract of a letter from Lieutenant and Commander Thomas de Hoghton, H.M. Gunboat 'Firm':—

"At 1 p.m. on the 14th, the Tyne bore NW distant 5 miles, and from the threatening appearance of the weather and low state of the barometer (28·80 ins.), I steered for Tynemouth intending to take shelter there; but in consequence of the increased force of the wind, which had veered to NW, I was unable to make the port. About 2h. 15m. the wind suddenly increased in force with great rapidity, and it blew with hurricane force from NW to N by W; the afternoon became darkened with the salt water blown into the air; the wind was terrific, blowing in violent squalls with heavy rain and hail, and a short breaking sea got up immediately; so fierce was the wind that no canvas could be shown, and I hove-to H.M. gunboat under steam, with tarpaulins lashed in the main and mizen rigging; when hove-to she headed about NE, but required careful watching to avoid shipping seas. Directly the force of the wind struck the ship the barometer rose rapidly, and I may note that just before this two claps of thunder were heard to the northward. The great force of the wind lasted till about 7 p.m., when it slightly

moderated and blew a heavy gale from N by W, accompanied of course by a very heavy sea. At midnight the barometer stood at 29·65 ins."

The Schooner 'Traveller' (No. 72) lost the NW gale due to storm-centre No. II. at 4 p.m. 13th in 57° 20′ N, and on the meridian of Greenwich, and the barometer continued to rise until 8 p.m., when it read 29·50 ins.; after this a brisk fall set in, and at midnight the wind was SE. The first entry of a gale for storm-centre No. III. is at 8 a.m. 14th, when it was blowing a strong gale from the E. At noon it was blowing a storm (force 11) from NE, barometer 28·56 ins. in 57° 30′ N and 1° 30′ W (see Plate VIII.).

The Steam-ship 'Sultan' (No. 67), in about 54° N and 5° E, first experienced the force of a full gale, from S, at 8 a.m. 14th, barometer 28·90 ins.: her lowest barometer was 28·44 ins. at 6 p.m., immediately after which the wind shifted to NNW, and the barometer rose briskly; this vessel does not report a stronger force than 10 (a whole gale).

The observations at Heligoland Lighthouse show the commencement of a fresh gale (force 8) from the SSE at 9 a.m. 14th, barometer 29·05 ins. The lowest barometer was 28·60 ins. at about 9 p.m. 14th, but the strongest force—a storm (force 11)—was some few hours later. The NW gale continued until midday 16th.

The following are a few remarks gathered from a study of the Charts. It is hoped they will prove of interest beyond tracing the special storm across the Atlantic. The Charts show the progressive movements of other storm-centres, and they also contain instances of two or more distinct storms blowing at the same time over the Atlantic.

Chart for October 9th. (Plate III.)

A storm-centre, No. I., was situated over the North Sea; no gale, however, was reported from the land stations in the British Islands or on the neighbouring coasts, but the ships' observations show a gale at noon in the vicinity of our Islands, and extending to about 500 miles westward of Ireland. An area of high barometric pressure (30·6 ins.) is shown to the north of the Azores. In about 47° 30′ N and 45° W a storm-centre, No. II., is shown accompanied by a strong SW gale.

Chart for October 10th. (Plate IV.)

Storm-centre No. I. has passed on to Norway, and a gale is reported from Norway and Sweden, but the wind does not appear to have blown with gale force at any of the land stations in the British Islands. The ships' observations, however, show a gale in the North Sea at noon. The area of high barometric pressure (30·6 ins.) still holds to the northward of the Azores, but has extended almost to the coast of Spain. Storm-centre No. II. has advanced about 900 miles to the north-eastward, which gives an hourly rate of about 40 miles. This depression has grown deeper since the 9th, and the storm area has considerably extended; its course was evidently influenced by the area of high barometric pressure to the north of the Azores. A SW gale due to this disturbance was blowing at less than 200 miles from the South of Ireland, and as yet no indication of its approach was shown in our Islands; the Chart of the 11th, however, shows

that the whole of the United Kingdom was under the influence of this storm. A fresh disturbance, storm-centre No. III., was apparently forming at about 200 miles to the south of Nova Scotia. It may be mentioned that this is the locality in which the warm water of the Gulf Stream running to the north-eastward meets the cold water of the Arctic current running to the south-westward, and is in all probability the breeding ground of many of our winter storms. It would certainly appear that we have here decided evidence of the formation of the storm which subsequently passed over the British Islands on October 13th and 14th. The observations of the United States Signal Service do not show any signs of a disturbance existing over America on the 9th. The Chart for the 11th shows that the disturbance has considerably developed, and its subsequent track is well shown.

Chart for October 11th. (Plate V.)

Storm-centre No. I. has passed off to the eastward, and No. II. has further advanced about 700 miles to the east-north-eastward, the centre being now slightly to the north of the Faeroe Islands. A gale is blowing in Norway and Sweden as well as in Scotland and Ireland. The area of high pressure (30·6 ins.) is still shown to the north of the Azores, but it has become decidedly less in extent. Storm-centre No. III. (which reached the British Islands on October 13th and 14th) has advanced about 230 miles to the eastward since the 9th, and has become much more decided. The barometer has risen considerably (30·6 ins.) on the coast of America, and gradients in the rear of depression No. III. have consequently become steep; the winds, however, are still generally only fresh, but two vessels experienced a gale, one just to the SE of Nova Scotia, the other on the banks of Newfoundland.

Chart for October 12th. (Plate VI.)

Storm-centre No. II. has only advanced between 200 and 300 miles to the eastward and still keeps its full energy, it is causing a gale in Norway and in the north of Scotland. The area of high barometer (30·6 ins.) to the north of the Azores remains almost unchanged; but vessels on its western edge, in about 40° N and 30° W, are now under the influence of the barometric depression or storm-centre No. III., which has advanced about 600 miles to the north-eastward since noon on the 11th; the readings at the centre are, however, still but very little below 30 ins., and the gale force which was shown on the 11th is not now to be traced. The high barometric pressure in the rear of depression No. III. is not so marked, and a fresh area of low pressure, No. V., is shown over America.

Chart for October 13th. (Plate VII.)

Storm-centre No. II. has advanced about 350 miles to the east-north-eastward, and has now reached the coast of Norway; the gale in the rear of this depression, however, still holds over the North Sea, and nearly the whole of the British Islands is under the influence of this disturbance. Storm-centre No. III. has advanced about 730 miles to the east-north-eastward, and the wind has now attained the force of a gale. The centre of disturbance is situated about 500 miles to the west of Galway, but as yet the

stations in the British Islands have scarcely come under its influence. At Valencia the first indication of its approach was at about 8 a.m. on the 13th, when the wind suddenly backed from NW by N to S; at this time the NW wind held all over Great Britain. At Holyhead the wind began to back at 11 a.m. At Stonyhurst the wind began to back at 1 p.m. The circulation of this disturbance (No. III.) would be fixed in a much more satisfactory manner if data could be obtained for its northern side. Mr. Buchan, who has kindly supplied the observations for the Faeroe Islands, has said that the Iceland observations are not forthcoming until the spring post, so that they cannot be incorporated in this paper. We know, however, that the steamer 'Bravo' was driven ashore on the Iceland coast on the 13th, her engines having broken down in a storm, and six of her crew and three passengers were drowned, and the vessel became a total wreck, so that it would certainly seem that the disturbance extended a considerable distance to the northward. The high pressure (30·45 ins.) in the neighbourhood of the Azores has been eaten away by the passing low pressure to the extent of about 0·15 in. A fresh storm-centre, No. IV., probably a subsidiary depression formed in the rear of the disturbance No. III., is shown in 42° 30′ N and 41° W. The high pressure which was situated over the coast of America on the 12th has advanced somewhat to the eastward. The area of low pressure, No. V., has also advanced to the east and is now near the entrance to the St. Lawrence River.

The Chart shows, in the most striking manner, the different winds due to different storm-centres. The whole of Great Britain is experiencing NW winds under the influence of an area of low barometric pressure (No. II.), situated on the coast of Norway, whilst a fresh to moderate W and SW gale is blowing in close proximity to the coast of Ireland, under the influence of a storm-centre (No. III.) in about 53° N and 23° W; this gale extends westward to about 28° W. In 46° N and 37° W a moderate gale is blowing from the NE under the influence of a third storm-centre (No. IV.) situated in 42° 30′ N and 41° W. A fourth disturbance (No. V.) is approaching the Atlantic from the continent of America. This affords a fair illustration of the difficulty of forecasting weather in the British Islands.

CHART FOR OCTOBER 14TH. (Plate VIII.)

Storm-centre No. II. has passed off to the eastward, and No. III. has advanced about 880 miles to the ENE since noon on the 13th, this gives an hourly rate of 39 miles for the progress of the disturbance; its centre is now situated over the North Sea, and it was probably at about this time that the storm had its greatest energy, at all events it is certain that the loss of life due to the storm was much greater in the German Ocean than elsewhere. The most disastrous effects were felt off the Berwickshire coast, which involved a loss of 200 lives. It will be seen by reference to the Chart that the centre of the storm must have passed completely over that part of the sea, so that the Fishing Fleet and other craft would not only have experienced the greatest violence of the storm, but the changes in the direction of the wind would have been extremely sudden. The extent of

this gale was very great and the force terrific over nearly the whole of the British Islands. The area of high barometric pressure in the vicinity of the Azores shows a still further decrease, the highest reading noted being now 30·35 ins. Storm-centre No. IV. has advanced about 750 miles to the east-north-eastward. Storm-centre No. V., which was over America on the 12th and 13th, has now entered the Atlantic, and is shown to the south of Newfoundland.

The second part of this Paper was intended to show the damage done to shipping on our coasts, and the wish was to form a Wreck and Casualty Chart of this Special Storm (13th to 15th) for the British Islands. The Secretary of Lloyd's has kindly furnished a list of the losses and casualties on the British coasts, so far as reported, due to the gale, for the information of the Society, and the Board of Trade kindly consented to supplement the information supplied by Lloyd's so as to render the Chart as complete as possible. Want of time has, however, prevented use being made of the offer made by the Board of Trade. The Trinity Board also gave permission for the inspection of the registers from the Light-ships on our coasts, but these registers are not received at the Trinity House until some time after date, and here again time could not be given to acquiring this information, although it would have formed a very valuable addition to the present paper. The published Weekly Wreck Returns for the second and third weeks in October show the number of vessels lost off the coast of the United Kingdom to be respectively 85 and 58; the number of lives lost and missing being 188 and 678 (a number almost unprecedented for one week).

LIST FURNISHED BY LLOYD'S, November 10th, 1881.

Losses and Casualties (see Note) reported at Lloyd's as having occurred on the Coasts of the British Islands during the Gale of October 13th, 14th and 15th, 1881.

Locality.	Abandoned.		Abandoned and Recovered.		Foundered.		Stranded.		Dismasted.		Sunk by Collision.		Lives Lost.
	Sail.	Steam.	Sail.	Steam.	Sail.	Steam.	Sail.	Steam.	Sail.	Steam.	Sail.	Steam.	
Sheerness	..	..	..	..	..	..	1	..	..	..	..	..	..
Queenboro'	..	..	..	..	..	1	..	..	..	..	..	..	..
Cant Sands	..	..	..	..	..	..	1	..	..	..	..	..	..
Kentish Flats	..	..	..	..	1	..	..	..	..	..	..	..	..
North Foreland, off	2	..	..	..	..	..	..	..	..	..	..	..	..
Ramsgate, near	1	..	..	..	..	..	..	..	2	..	..	..	..
Goodwin	..	..	..	..	..	..	1	..	..	..	..	..	..
Do. East of	..	..	1	..	..	..	..	..	..	..	..	..	3
Southsea	..	..	..	..	..	..	1	..	..	..	..	..	..
Cowes	..	..	..	..	..	..	..	..	1	..	..	..	..
Shanklin	..	..	..	..	..	..	1	..	..	..	..	..	..
Weymouth	..	..	1	..	..	..	..	..	..	..	..	..	..
Plymouth, 50m. W. of	..	..	..	..	1	..	..	..	..	..	..	..	..
Falmouth	..	..	..	..	..	..	2	..	..	..	..	..	..

Losses and Casualties, &c.—*Continued.*

Locality.	Abandoned.		Abandoned and Recovered.		Foundered.		Stranded.		Dismasted.		Sunk by Collision.		Lives Lost.
	Sail.	Steam.	Sail.	Steam.	Sail.	Steam.	Sail.	Steam.	Sail.	Steam.	Sail.	Steam.	
Doombar, Padstow							1						
Burnham, near Bridgwater							5						
Dunball							1						1
Bristol Channel							2						
Swash, near Bristol					1								
Old River, Bristol							1						
Kingroad, Bristol							1						
Avonmouth							2						1
Usk River, Mouth of							2						
Monkstone, Cardiff											1		
Cardiff									2				
Do. Ogmore River								1					
Penarth					1				3				
Britonferry							1						
Swansea							2						
Mumbles, Britonferry							1						
Burryport							1						
Pembrey								1					
Pembroke							1						
Pill Point, Milford							9						
Aberdovery							1						
Harlach, near Pwllheli							1						
Aberforth							1						
Abererch, St. Tudwal's Roads							2						
St. Tudwal Roads							1						
Pwllheli							3						
Nevin								1					
Port Dinllarn		1											
Holyhead	1						3						
Do. Salt Island							2						
Beaumaris							1						
Great Orm's Head							1						
Mostyn Roads							2						
New Brighton					1								1
Garston							4						
Liverpool							2						
Do. NW Light									1				
Formby												1	
Isle of Man, off									1				
Ramsay, Isle of Man	1												
Bah[illegible]ithvn. 6m. SE. of									1				
Skerr[illegible]							5						
Dundal[illegible]									1				
Bangor B[illegible]Co. Down							1						
Drummore-by-Stranraer							1						
Ailsa Craig									1				
Bowmore							1						
Greenock							1	1					
Blue Mull Sound							1						
Unst, near Stromness							1						
Lossiemouth	1												
Peterhead							1						
Skaterawe							1						
Dundee, off					1								
May Island, 3m. E. of Burntisland	1												

Losses and Casualties, &c.—*Continued.*

Locality.	Abandoned.		Abandoned and Recovered.		Foundered.		Stranded.		Dismasted.		Sunk by Collision.		Lives Lost.
	Sail.	Steam.	Sail.	Steam.	Sail.	Steam.	Sail.	Steam.	Sail.	Steam.	Sail.	Steam.	
Firth of Forth, off	1	..	..	..	..	..	..	..	..	..	..	..	..
Incharvie Island	..	..	..	..	..	..	1	..	..	..	..	..	..
Granton, off	..	..	..	..	..	..	..	..	1	..	..	..	..
Leith Roads	..	..	..	..	..	..	..	..	1	..	..	..	..
N. Sea, E. Coast	3	..	..	..	4	..	..	..	..	1	..	..	..
Dunbar	..	..	..	..	1	..	1	..	..	..	..	..	7
Red Heugh, near Dunbar	..	..	..	..	..	..	..	1	..	..	..	..	..
St. Abb's Head	1	..	..	..	..	..	..	..	..	..	..	..	..
Eyemouth	..	..	..	..	1	..	..	..	..	..	..	..	..
Coswick	..	..	..	..	..	..	2	..	..	..	..	..	..
Berwick	..	..	..	..	..	..	1	..	..	..	..	..	..
Spittal Point, Berwick	..	..	..	..	..	..	2	..	..	..	..	..	2
Holy Island, N. side	..	..	..	..	..	..	1	1	..	..	..	..	..
Fern Island	..	..	..	..	..	..	1	..	..	..	..	..	..
Coquet, off	1	..	..	..	..	..	..	..	..	..	..	..	..
Sow and Pigs, near Blyth	..	..	..	..	1	..	..	..	..	..	..	..	3
Blyth	..	..	..	..	..	1	..	..	..	..	..	..	..
Shields, near	..	..	..	..	1	2	1	..	..	..	..	..	17
North Shields, near	..	..	..	..	..	1	..	..	..	..	..	..	..
Tyne, off	..	..	..	..	1	1	..	..	1	..	..	..	28
Seaham, near	..	..	..	..	2	..	..	..	..	..	..	..	..
Hartlepool, off	..	..	1	..	..	..	..	..	..	..	..	..	..
Yorkshire Coast	..	..	..	..	1	..	..	..	..	..	..	..	..
Middlesboro'	..	..	..	..	1	..	..	..	..	..	..	..	..
Whitby, N. of	..	..	1	..	..	..	..	..	..	..	..	..	..
Scarboro'	1	..	2	..	..	..	..	..	2	..	..	..	..
Huntly Fort, near Scarboro'	..	..	..	..	..	..	..	..	..	1	..	..	..
Speeton Cliff, near Scarboro'	..	..	..	..	1	..	..	..	..	..	..	..	..
Filey	..	..	..	..	..	..	1	..	..	..	..	..	..
Flamboro' Head, 50m. SE of	..	..	..	..	1	..	..	..	..	..	..	..	..
Withernsea	..	..	..	..	..	..	1	..	..	..	..	..	..
Kilnsea	..	..	..	..	..	..	2	..	..	..	..	..	..
Spurn, 100m. W. by S. ½ S.	..	1	..	..	..	..	..	..	..	..	..	..	..
Do. S. of	1	..	..	..	..	..	..	..	..	..	..	..	..
Do. Point	..	..	..	..	1	..	1	..	..	..	..	..	..
Do. 60m. off	..	..	..	..	1	..	..	..	..	..	..	..	3
Humber River	..	..	..	..	..	..	1	..	..	..	..	..	..
Do. off	..	..	..	..	..	..	..	..	1	..	..	..	..
Lincolnshire Coast	..	..	1	..	..	..	..	..	..	..	..	..	..
Do. 53m. N. 3 E.	..	..	1	..	..	..	..	..	..	..	..	..	..
Cleeness	..	..	..	..	..	..	1	..	..	..	..	..	..
Grimsby	..	..	2	..	..	..	..	..	4	..	..	..	..
Hale Sand, Saltfleet	..	..	..	..	..	..	1	..	..	..	..	..	..
Saltfleet	..	..	..	..	..	..	1	..	..	..	..	..	..
Leman, 8m. off	1	..	..	..	..	..	..	..	..	..	..	..	..
Do. 50m. N. by E.	..	..	1	..	..	..	..	..	..	..	..	..	..
Hunstanton	..	..	..	..	1	..	..	..	..	..	..	..	..
Brancaster, near Boston	..	..	..	..	..	..	1	..	..	..	..	..	..
Hasboro'	..	..	..	..	..	..	1	..	..	..	..	..	..
Scroby Sands	..	..	..	..	1	..	..	..	..	..	..	..	..
Yarmouth	..	..	..	..	..	..	..	..	2	..	..	..	..
Lowestoft, 30m. SE. of	..	..	..	..	1	..	..	..	..	..	..	..	..
Do. 40m. „	..	..	..	..	1	..	..	..	..	..	..	..	..
Do. off	..	..	..	..	..	..	..	..	2	..	..	..	..
Middle Sands, Lowestoft	..	..	..	..	..	..	1	..	..	..	..	..	..
Newcome Sands, near Lowestoft	..	..	..	..	..	..	1	..	..	..	..	..	..
Barnard Sand	..	..	..	..	..	..	1	..	..	..	..	..	..

Losses and Casualties, &c.—*Continued.*

Locality.	Abandoned.		Abandoned and Recovered.		Foundered.		Stranded.		Dismasted.		Sunk by Collision.		Lives Lost.
	Sail.	Steam.	Sail.	Steam.	Sail.	Steam.	Sail.	Steam.	Sail.	Steam.	Sail.	Steam.	
Kessingland	..	..	..	..	..	..	1	..	..	..	..	..	..
The Wold	..	..	..	..	1	..	..	..	..	..	..	..	..
Aldborough	..	..	..	..	..	..	1	..	..	..	..	..	..
Orfordness, off	..	..	..	..	1	..	..	..	..	..	..	..	..
Walton-on-Naze	..	..	..	..	..	..	1	..	..	..	..	..	..
Bosmere Deeps, Ipswich	..	..	..	..	..	..	1	..	..	..	..	..	..
Maplin Sands	..	..	1	..	..	..	1	..	1	..	..	..	..
Shoebury Sand	..	..	..	..	..	..	1	...	..	..	..	..	..
Leigh Middle	..	..	..	..	..	..	1	..	..	..	..	..	..

10 *Vessels* reported with damage at different parts of the Coast with an aggregate loss of 17 *lives.*
Of 11 *Vessels* it is supposed the crews were drowned.

NOTE.—There were numerous other casualties that were of a less serious nature; these are not included.

Vessels "*stranded.*"—Many of these in this return were got off, more or less damaged.

At Berwick there was supposed to have been a number of fishing vessels lost, involving a heavy loss of life.

At Yarmouth it is feared there are several boats lost, as they have not yet been heard of.

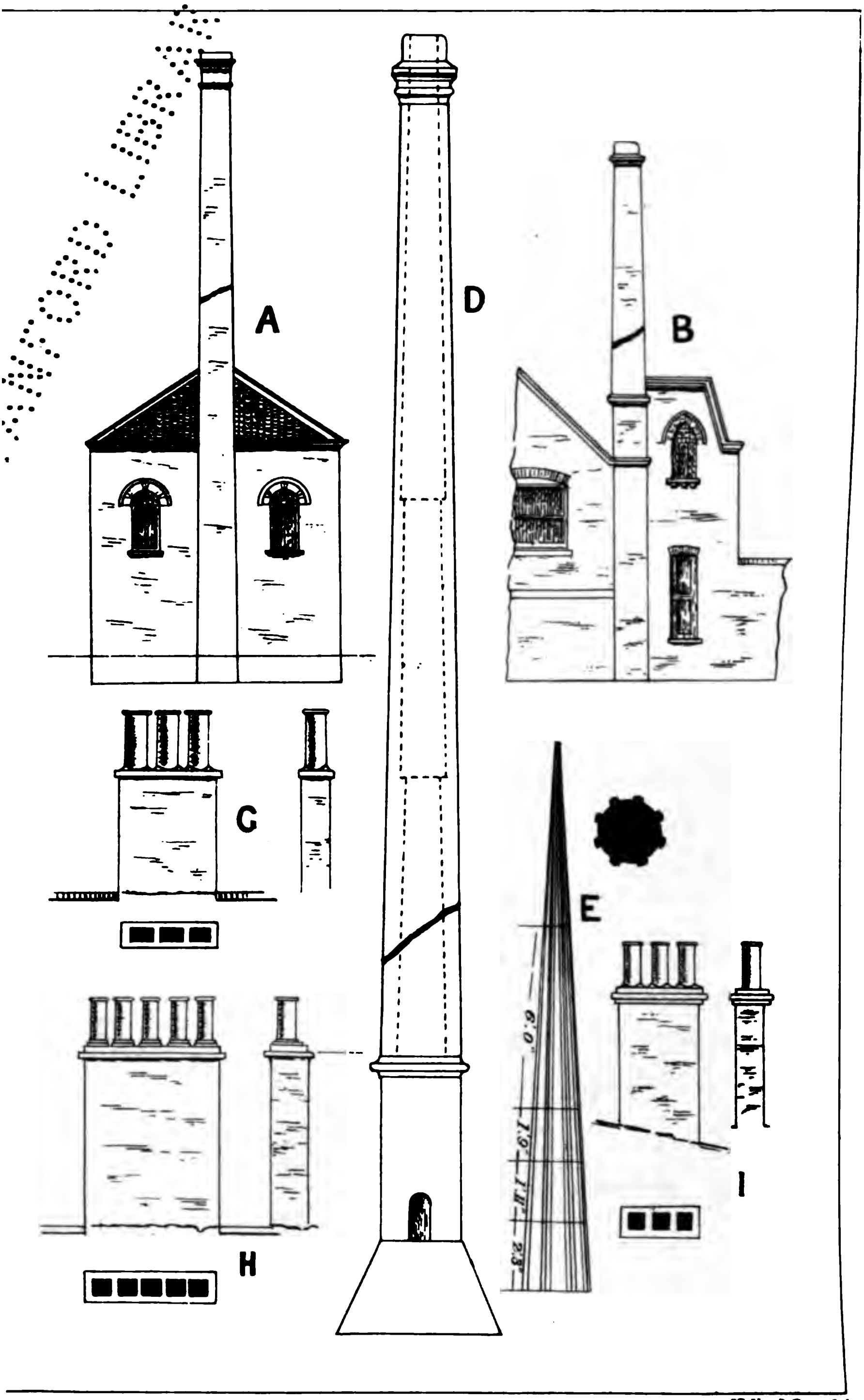
The information as to the time of casualty not being fully furnished, it has, therefore, been omitted.

The following is a list of the vessels whose logs have been used for this Paper. The numbers prefixed have reference to the numbers used on the Charts and placed at the ends of the respective arrows.

Reference Number used on Charts.	Name of Ship and Captain.	Information furnished by
1.	Shun Lee, Barque. John M. Gray	Meteorological Office.
2.	Mertola, Barque. E. W. Turner	
3.	Algeria, S.S. J. Hill	
4.	Nile, S.S. W. W. Herbert	Royal Mail Steam Packet Company.
5.	Tamar, S.S. A. E. Bell	
6.	Nova Scotian, S.S. Wm. Richardson	Montreal Ocean Steam Ship Co.
7.	Caspian, S.S. B. Thompson	
8.	Moravian, S.S. F. Archer	
9.	Sarmatian, S.S. John Graham	
10.	Duart Castle, S.S. H. Barnes	Donald Currie & Co.
11.	Kinfauns Castle, S.S. A. Winchester	
12.	Haytian, S.S. —Peter	West India & Pacific Steam Ship Co.
13.	Palmyra, S.S. —Durant	Cunard Steam Ship Company.
14.	Atlas, S.S. —Hoseason	
15.	Bothnia, S.S. —McMickan	
16.	Batavia, S.S. —J. E. Mouland	
17.	Durban, S.S. —Warleigh	Union Steamship Company.
18.	Chilian, S.S. P. Reid	West India & Pacific Steam Ship Co.
19.	Victoria, S.S. J. B. Murray	Henderson Brothers.
20.	California, S.S. —Young	
21.	Australia, S.S. J. P. Hassall	Peninsular & Orient. Steam Nav. Co.

Reference Number used on Charts.	Name of Ship and Captain.	Information furnished by
22.	Burdwan, Barque. J. F. Ainscow	T. and J. Brocklebank.
23.	Alexandra, Ship. A. G. Marley	T. and J. Brocklebank.
24.	Chinsura, Ship. T. Robinson	T. and J. Brocklebank.
25.	H.M.S. Warrior, S.S. S. P. Townsend	G. J. Symons, F.R.S.
26.	City of Montreal, S.S. ?	Meteorological Office.
27.	Samaria, S.S. ?	Meteorological Office.
28.	Scythia, S.S. ?	Meteorological Office.
29.	Italy, S.S. R. P. Williams	National Steam Ship Company.
30.	Erin, S.S. W. A. Griffiths	National Steam Ship Company.
31.	Polynesian, S.S. R. Brown..........	Montreal Ocean Steam Ship Co.
32.	H.M.S. Minotaur, S.S. H. H. Rawson	Meteorological Office.
33.	Bolivia, S.S........................	Henderson Brothers.
34.	H.M.S. Alexandra, S.S. Lord Walter T. Kerr	Meteorological Office.
35.	H.M.S. Superb, S.S. T. Le H. Ward..	Meteorological Office.
36.	H.M.S. Blanche, S.S. C. G. F. Knowles	Meteorological Office.
37.	Iron Cross, Ship. R. Randall	Meteorological Office.
38.	City of Perth, Ship. C. Macdonald ..	Captain C. Macdonald.
39.	Adriatic, S.S. ?	Ismay, Imrie & Co.
40.	Republic, S.S. P. S. Irving..........	Ismay, Imrie & Co.
41.	Britannic, S.S. H. Perry	Ismay, Imrie & Co.
42.	Germanic, S.S. C. Kennedy	Ismay, Imrie & Co.
43.	Galatia, S.S. ?........	Henderson Brothers.
44.	Marathon, S.S. — Woolfenden	Cunard Steam Ship Company.
45.	Gallia, S.S. — Hains	Cunard Steam Ship Company.
46.	Catalonia, S.S. Wm. Gill	Cunard Steam Ship Company.
47.	Alsatia, S.S. John Craig............	Henderson Brothers.
48.	Rhein, S.S. H. A. F. Neynaber	Deutsche Seewarte, Hamburg.
49.	Adolph, Brig. O. Kampehl	Deutsche Seewarte, Hamburg.
50.	Braunshweig, S.S. C. Pohle	Deutsche Seewarte, Hamburg.
51.	Elena, Barque. J. Steenken	Deutsche Seewarte, Hamburg.
52.	Margaretha Gaiser, Barque.—Wienefeld	Deutsche Seewarte, Hamburg.
53.	Oder, S.S. C. Undütsch	Deutsche Seewarte, Hamburg.
54.	General Werder, S.S. H. Christoffers	Deutsche Seewarte, Hamburg.
55.	Herder, S.S. G. Tischbein	Deutsche Seewarte, Hamburg.
56.	Elbe, S.S. Chr. Leist	Deutsche Seewarte, Hamburg.
57.	Köln, S.S. Th. Tüngst	Deutsche Seewarte, Hamburg.
58.	Cimbria, S.S. C. Ludwig	Deutsche Seewarte, Hamburg.
59.	Strassburg, S.S. O. Heimbruch......	Deutsche Seewarte, Hamburg.
60.	Hermann, S.S. H. Baur	Deutsche Seewarte, Hamburg.
61.	Donau, S.S. R. Bussius	Deutsche Seewarte, Hamburg.
62.	Salier, S.S. C. Wiegand	Deutsche Seewarte, Hamburg.
63.	Westphalia, S.S. — Schwensen	Deutsche Seewarte, Hamburg.
64.	Patagonia, Barque. E. H. Hellwege..	Deutsche Seewarte, Hamburg.
65.	Maria Adelaide, Barque. B. Krause ..	Deutsche Seewarte, Hamburg.
66.	Terpsichore, Ship. T. F. F. Köhler ..	Deutsche Seewarte, Hamburg.
67.	Sultan, S.S. W. Barron	Meteorological Office.
68.	H.M.S. Orontes, S.S. R. G. Kinahan	Meteorological Office.
69.	Maritzburg, Barque. Wm. G. Belleville	Meteorological Office.
70.	City of Rome, S.S. Jas. Kennedy....	Inman Steam Ship Company.
71.	Cavalier, Barque. M. Jackson	Meteorological Office.
72.	Traveller, Schooner. A. Simpson	Meteorological Office.
73.	Thames, S.S. A. H. Luckhurst	Meteorological Office.
74.	H.M.S. Tyne, S.S. J. E. Stokes	Meteorological Office.
75.	H.M.S. Coquette, S.S. J. L. Burr	Meteorological Office.
76.	At H. M. Dockyard, Bermuda	Meteorological Office.
77.	H.M.S. Crocodile, S.S. C. S. Cardale	Meteorological Office.
78.	H.M.S. Druid, S.S. W. R. Kennedy ..	Meteorological Office.
79.	H.M.S. Northampton, S.S. E. Drummond	Meteorological Office.
80.	Hope, Barque. Jas. Campbell	Meteorological Office.
81.	H.M.S. Sappho, S.S. B. F. Clerk	Meteorological Office.
82.	H.M. Gunboat Firm, S.S. T. De Hoghton	Meteorological Office.
83.	Sunbeam, Steam Yacht...............	Sir Thos. Brassey's letter to *The Field*.

STRUCTURAL DAMAGE CAUSED BY THE GALE OF OCTOBER 14TH 1881.



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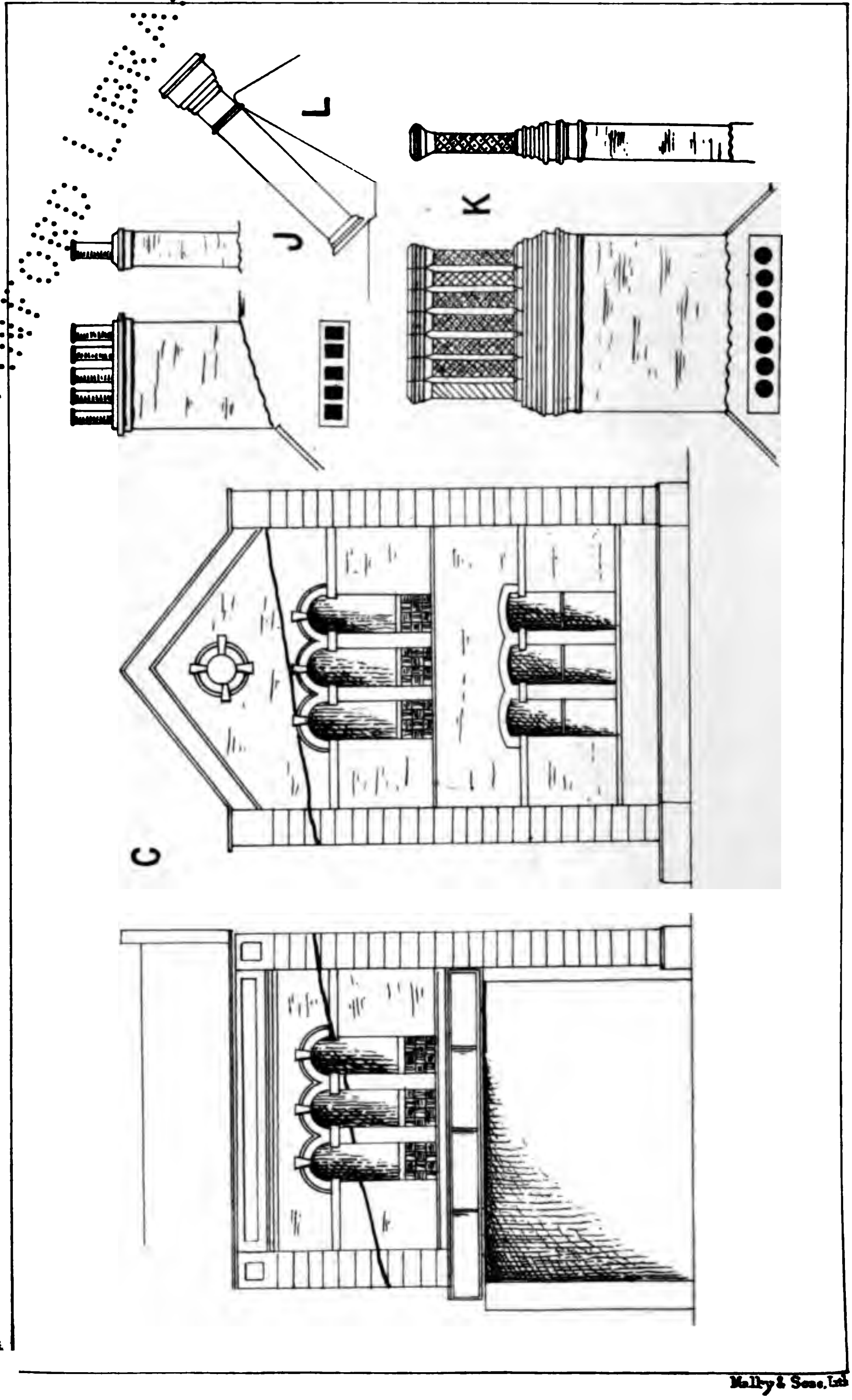

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ON THE STRUCTURAL DAMAGE CAUSED BY THE GALE OF OCTOBER 13TH-14TH, 1881, AS INDICATIVE OF WIND FORCE. By J. WALLACE PEGGS, Assoc.M.Inst.C.E.,F.M.S. (Plates IX.-X.)

[Read November 16th, 1881.]

THE object of the following Paper has been, not so much to give a description of the structural damage in different parts of the country or to epitomise the cases of it which I have been able to collect and which others have kindly forwarded to me, but to give a selection of well marked instances of damage to structures which should offer some reliable data for determining the probable pressure which caused these structures to fail.

The structural damage due to the gale of October 13th-14th last has been very great and severely felt in some particular places, and it seems to me that even in several towns there have been lines or belts of local maxima of destruction, indicating the existence of paths of greater intensity of pressure.

We find that the damage done includes houses which have been destroyed or unroofed, factory chimney shafts overturned, stacks of chimneys blown down, walls, church spires, pinnacles and turrets have fallen, windows have been blown in, stone finials blown off churches, with much other damage of like nature.

The cases to hand are numerous, and some of them being well defined, offer a good basis for investigating the mechanical effect exerted in producing them. Among the most useful class for the purposes of our investigation are factory chimney shafts, stacks of chimneys, high gables, &c.

There is also an interesting class of cases where objects have been taken up bodily and moved for great distances through the air. One such occurred at Alnwick, where a plank 11 inches wide, 3 inches thick, and 20 feet long, having been lifted up from a barge by the wind, was sent horizontally about 100 yards and then twirled over and over endwise for a like distance, thereby indicating a gyratory motion in the air.

Since the Tay Bridge accident, attention has been once more directed to the subject of wind pressures, and also the means employed for registering the velocity and pressure of the wind. We have it from a great authority on engineering, Mr. Hawksley, that "the instruments at present in use are little better than philosophical toys, and that in general they afford no direct comparable or reliable indications of either velocities or pressures."

Now, although we cannot quite admit Mr. Hawksley's remark about anemometer observations generally,—for there must be a great quantity of valuable information collected in the records of the anemometers fixed at our observatories which will be very useful in the future,—yet no one who has given consideration to this subject can be otherwise than dissatisfied with the instruments at present in use.

The pressure-plate instruments as now constructed give too much, as they record not only the front pressure on the plate but the partial vacuum at the back of the plate, and I believe it will be found that two-thirds of the regis-

tered amount is approximately the true pressure. The Robinson cup anemometer for registering the velocities of the wind is open to much objection, because we do not really measure its true velocity, but the resultant velocity in the horizontal plane.

Another most important fact, which must be recognised at no distant date in wind observations, is that of the inclination upwards or downwards from the horizontal line. It is assumed at present in all the usual apparatus that the direction is truly horizontal; that such is not, however, the case, has been pointed out by M. Dechevrens in a very able paper, "Sur l'inclinaison des Vents," "Nouvelle Girouette pour observer cette inclinaison," and shown by his observations taken at several stations on the China coast with a new kind of anemometer he calls an inclination anemometer.

Mr. Fraser has also invented an apparatus for measuring this inclination of the wind to the horizon. The results of his experiments are that air currents are much modified by the ground over which they pass. In his experiments in front of the Observatory at Edinburgh, the angle was found to be 45° and upwards; on the Salisbury Crags it ranged from 45° to 75°, while on level ground it was found to be 15°.

I make this digression to show that the instruments at present in use will probably require to be modified and amplified if we are to form correct ideas of the motion, direction, and pressure of air currents.

Another difficulty I have found is in measuring the exact intensity of sudden gusts of wind. The Hagemann anemometer seemed to promise us an instrument for this purpose, but in its present form I fear it is not all that might be desired for practical work.

That wind moving over a district, by being trained by gorges, valleys, &c., may become more concentrated and acquire a greater velocity there can be no doubt, and we can even imagine in a town that some building and lines of buildings may also affect it similarly.

There is also an effect produced on some structures, notably on chimney shafts, where recurring gusts of wind set up a pendulum-like motion, which, increasing with each gust, at length becomes sufficient to overturn the structure.

To pass on to the cases of structural damage which have been chosen from among others collected, and which are shown on the diagrams. The individual examples are distinguished by the letters A, B, C, D, E, F, G, &c.

These examples have been all carefully measured and drawn on the spot, and sketches made of the surroundings and of the position occupied by the damaged structure. Some little difficulty has been found in obtaining the dimensions, and the lightning-conductor bands have been of great service in checking dimensions and arriving at the exact height of fallen chimney shafts. Without this aid many examples would have been lost.

Case A is that of a brewery shaft at Barking, in Essex, which fell in a sudden gust at 12.40 p.m. on October 14th, the wind being about SW. The height from the ground was 58 feet, it was built into the structure as

shown on the diagram, was 8 feet square where it broke off, the brickwork being 9 inches thick; the length blown off was 22 feet 7 inches.

Calculations which I have made give the weight of brickwork at 13,800 lbs., acting through the centre of gravity. The centre of pressure of the part blown off is found to be 10·5 feet from point of fracture, and, by taking the moments, we arrive at 31·8 lbs. per square foot as the amount of pressure required to overturn this portion of the shaft.

Case B is a factory shaft in Goswell Road, which the owner kindly allowed me to inspect and measure. The shaft was built square, and had been standing some years. The top part of it was blown off about 2 p.m., and went through the adjoining buildings. The total height of this shaft from the ground line was 65 ft. and faced the SW. The portion blown off measures 3 feet 4½ inches, is square at the point of fracture, 2 feet 8 inches at top, and 26 feet 6 inches in height.

The shaft was built into the adjoining building as shown upon the diagram.

I may here remark that the strength due to the mortar joints is entirely omitted in all these calculations, because from a study of these chimney shafts it will be seen that before failure an oscillating motion is set up by previous gusts of wind, and that the joint where the fracture happens is already broken before the shaft is finally blown over.

The weight of brickwork displaced in this case is found to be 22,080 lbs., and the centre of pressure, calculated at 12 feet 9 inches from the base of fracture, gives a pressure of 37 lbs. per square foot as the acting force of the wind.

Case C.—This is the case of a large gable end and return wall which had been recently built at the New Goods Station, Great Eastern Railway, Shoreditch, London.

The diagram indicates the nature of the structure. It fell about 2 p.m. The line of fracture is shown upon the diagram by a full black line.

The two walls formed a right angled obstruction, and the wind struck the surface of the walls obliquely. From a consideration of the normal pressure required to overturn the walls, we find the probable pressure of the wind to have been 21 lbs. per square foot.

Case D.—This is a chimney shaft built at West Bromwich about 8 years ago. It is a square shaft of total height from the ground 127 feet 6 inches, and the part blown off measures 90 feet with a base of 8 feet 4 inches, and at top 6 feet 6 inches square.

The thicknesses of brick-work are 9 inches at the top portion, for 20 feet down, 14 inches for the next 30 feet down, 18 inches thick for the next 30 feet, and 23 inches thick for lower part of the shaft. The base being as shown upon the diagram.

The shaft faced SW and NE, and fell towards the NE.

The calculated weight of brick-work amounts to 332,467 lbs. or 103·8 tons.

The centre of pressure is taken at 45 feet above the base of fracture, and I find the pressure necessary to overturn such a structure to be 40·5 lbs, per square foot of surface.

Case E.—This is the spire of St. Michael's Church, Blackheath Park. The spire is of stone, built in an octagonal form, and having mouldings projecting from the edges of the pyramid, as shown in the section.

The whole mass blown off was dowelled together at the joints by lead run in, in the direction shown upon the diagram, so that the portion which fell was really a monolith, and blew off from the first joint where there was no dowel or joggle.

The ribs or mouldings would offer great resistance to the passage of the wind, it is probably owing to their presence that the spire blew off.

From the calculation made, it is found that a pressure of about 19 lbs. per square foot was necessary to displace the stone.

Case F.—This is a similar case to the previous one. It is a stone turret from a church in the Southgate Road, near the Rosemary Branch Bridge, Regent's Canal, London. It is octagonal on plan and pyramidal on elevation. It also had mouldings on the angles, but these were round instead of having the angular section of those in the last case.

The turret surmounted a high gable end and was about 100 feet from the ground.

The portion broken off was monolithic, being tied together by the iron rod which formed the vane and terminal, being carried down and bolted under a joint in the stone.

I have been unable to develop this case owing to the want of proper experiments being made as to the support given by the iron vane and terminal, which ironwork greatly complicates the question.

Cases G, H, I, J, K, L, are stacks of chimneys which were blown down in various parts of London and neighbourhood, as will be seen from the diagram.

These stacks of chimneys present very valuable and interesting objects for the study of wind pressures. The case marked (L), sent to me from Clifton, shows that the stack fell as a monolith turning about a point, and is worthy of particular attention.

Taking one such stack, as given in the examples in the diagrams, we have to consider what are the conditions of the structure as regards stability.

We have:—

First. The weight of brickwork in the part under discussion.

Second. A surface of so many square feet exposed to the wind either normally or at an oblique angle.

Third. The strength of the mortar joint to resist strain.

Fourth. A pressure on the front surface due to the impulsive action of the wind.

Fifth. The partial vacuum at the back of the stack.

Sixth. The additional surface exposed, due to projections over sailing courses of brickwork around top of stack, and, in old brickwork, open joints of the work itself.

The chimney pots over flues, of terra cotta, red clay, &c. The shape and height of such pots.

The pressures developed in the above-mentioned cases, G, H, I, J, K, &c., have been worked out, and give an average result of 22·5 lbs. per square foot.

A chimney stack set up against the wind, as in our examples, obstructs very much more wind than that impinging on its surface; it piles up the air in front and at the side much in the same way as a running stream piles up water in front of an obstruction, such as a stake or pile driven into its bed, and so it sustains a greater pressure than that due to its superficial area alone.

Air, being elastic, causes a much greater disturbance around an obstruction than water, and so a greater pressure proportionately to its weight and velocity.

From these considerations we see that surfaces with open spaces in them, such as bridge girders of lattice form, must not be measured by the actual net area of the bars, but an allowance must be made for much more, approximating to the solid web girder. The rush of air past the bars causes a '*vena contracta.*' (This will probably, I think, be smaller in air than in water.)

I may here remark with reference to the pressures given by Mr. Symons in his paper, that of the Royal Observatory, Greenwich, 53 lbs. per square foot, and that of Lloyds', at the Royal Exchange, 19 lbs. per square foot, that an interesting experiment was carried on at the South Metropolitan Gas Works during the height of the gale on Friday, October 14th.

Mr. Livesay says, in a letter describing the experiment, "The observations were made at a height of 95 feet above the ground, with nothing to obstruct the wind for a distance of several miles. The apparatus used was an ordinary glass gauge, such as used in gas works, and attached by a flexible tube with a square hopper-shaped funnel and always kept face to the wind. I noticed that the wind came in most violent gusts of very varying force, seldom, however, attaining a pressure of more than 10 lbs. on the square foot. The greatest force observed during the hour 2 to 3 o'clock was 26 lbs. per square foot; this pressure was, however, not sustained, but fell immediately."

This experiment having been made in the neighbourhood of Greenwich Observatory was very interesting when taken in conjunction with the reading of 53 lbs. per square foot at the Royal Observatory, and it would appear that this latter reading is from some cause excessive.

In conclusion, I would suggest as a fitting work for this Society that it should endeavour to form a Conference similar to the Lightning Rod Conference, composed of delegates from various societies who are specially interested in this subject for the purpose of collecting information available in relation to this subject of wind pressure, and further to suggest the best way of conducting and carrying out experiments, which shall tend to the elucidation of the laws of wind pressures and the impulsive action of the wind, which laws are so little understood at the present time.

The magnitude of the forces in operation in nature is perhaps nowhere more evident than in the effects produced by wind. Whether we consider the surging waves of the sea and the tremendous power developed by them, or the columns of water drawn up by the power of the wind and moving

along in a certain path, or finally the sand of the desert, drawn up in a column some hundreds of feet high, all point to the mighty power of the wind.

The great storm of November 1703 seems to have been as memorable for the damage done to buildings as that of October 1881, which we are now considering. During that storm it is stated that no less than 800 dwellings were laid in ruins and 2,000 stacks of chimneys were blown down in London alone. The lead roof covering was stripped off 100 churches, rolled up and hurled incredible distances. Near Shaftesbury it is recorded that a stone of 400 lbs. weight was lifted and carried some distance. It was also during this storm that the first lighthouse built on the Eddystone Rock was swept away and with it also its intrepid constructor.

Colonel Pasley records in an interesting communication, made to the Institution of Civil Engineers, that on November 29th, 1836, he saw a roof in the dockyard at Chatham move up and down, and eventually blown off and carried about a distance of 50 yards. The portion of roof was 50 feet by 40 feet.

In November 1836 the Chain Pier at Brighton was greatly damaged, the roadway being almost entirely wrecked. During the storm of October 1838 the Suspension Bridge at Montrose was destroyed by the lifting action of the wind.

In the storms of January 1836, from WSW, and January 1839, from SW, the Menai Suspension Bridge was much damaged owing to the undulatory motion set up by the lifting power of the wind.

These facts are very interesting just now, when so much consideration is being given to bridge structures and the effect of wind pressures on them.

Mr. Smeaton, in conjunction with Mr. Rouse, published tables in a paper sent to the Royal Society in 1759, of the velocity of the wind and the corresponding pressures. This Table has been used by Engineers ever since for converting velocity into pressure and *vice versâ*. The Table was constructed from certain experiments made by revolving arms, and had special reference to windmills.

DISCUSSION.

Mr. Dines said that nearly 25 years ago the subject of wind pressure had come under his notice, from his having to build a church spire, in an exposed place, and at an elevation of 750 ft. above the sea. He felt rather nervous about the effect of the wind, and therefore went carefully into the calculation, which left a good margin on the side of safety. He would not say the wind had increased in force since the erection of so many anemometers over the country, but our idea of that force had greatly increased. 20 to 25 lbs. per square foot used to be considered as the limit, now we hear of as much as 60 or 70 lbs. Taking an ordinary chimney 6 ft. high and 5 ft. wide, of which there are thousands in London, if it were free to turn upon its lower edge, a steady pressure of about 27 lbs. per square foot would throw it over. So far he might speak with almost mathematical certainty, but there was one element in the question most uncertain, and that was the cohesion of the mortar joint. Numerous experiments had been made upon the tensile strength of cement, but that of mortar appeared to have

been neglected; the only account he could find gave it 50 lbs. to the square inch. On looking to the section of the chimney shown on the diagram, it would be seen no part of the brickwork was more than 4½ inches thick. What with the weather on the outside, and the heat within the chimney, not much dependence could be placed upon the mortar, but he could not help thinking it was of too much importance to be dispensed with altogether ; as a tension of only 1 lb. to the square inch would balance a pressure of 4 lbs. to the foot against the face of the chimney. Good mortar was in some cases stronger than the brick, and, in fact, the mortar in a chimney might be of any strength, from nothing up to 100 lbs. per square inch, and therefore, if well built, might defy the power of any wind. He supposed the question of difference of rainfall with elevation might now be considered as settled, at all events he had dismantled the gauges placed upon his tower, and had erected something in their place to get at the force of the wind ; it consisted of a box hung upon centres at the back, loaded with iron and stone, weighing nearly 1 cwt., which was placed with its face to the wind. A cord at the back, passing over a pulley, and to which a scale was attached, enabled him to adjust the overturning weight to anything he pleased. On that morning the wind was so strong, that he had to use one hand to keep his hat on ; but the force of the wind was not equal to a steady pressure of 5 lbs. to the foot—he had left it so that 10 lbs. to the foot would overturn it. Wind pressure was of great importance both to engineers and builders, but after all it was a meteorological question, and one that ought to be solved. He was quite aware the apparatus he had in use was imperfect, as he had to be upon the spot in order to keep its face to the wind, but he had little doubt it would throw some light upon the subject.

Mr. LAW observed that he did not know what steps had been taken in regard to the reduction of the observations upon structures that had been upset to ascertain the direction in which the wind met the face of those structures. A very large portion of the surface of an ordinary chimney stack consisted of the chimney pots, usually cylindrical in form, thus reducing the effect of the wind upon them by one-half, as all cylindrical, spherical, or surfaces inclined at an angle of 45° presented but half the resistance to the wind that a flat surface of the same area did. The law as to the pressure of wind meeting a plane surface at an angle was as follows :—

Let $f =$ force of wind.
$a =$ area of surface.
$C =$ angle of wind with surface.
$p =$ pressure perpendicular to the surface.
$p_1 =$ pressure in the direction of the wind.
$p_2 =$ pressure perpendicular to the same direction.

Then $p = af \sin.^2 C.$
$p_1 = af \sin.^3 C.$
and $p_2 = af \sin.^2 C \cos. C.$

It was of great importance to observe the direction of the wind in regard to structures, as, if it blew anglewise, the force upon the structure was at once reduced, while the strength or power of resistance was generally increased. Other important points were as to the vacuum formed at the back of a structure, which depended in a great measure upon the extent of the same, and the relative effect the wind had upon the near and further sides of piers and structures such as the Tay bridge, consisting of open framework or lattice girders, where there was not only the direct force of the wind upon the exposed girder, but the diminished force upon the further and partially protected girder. The result of very careful calculations as to the force required to overturn the various carriages in the train which was precipitated into the Tay showed that the pressure ranged from about 35 lbs. per square foot in the case of the lightest (the 2nd class) to about 260 lbs. for the locomotive itself.

Mr. STANLEY said, with reference to Mr. Symons's observations as to the lifting power of the wind, that in his own particular locality (South Norwood) it seemed to have drifted directly downwards, blowing nearly from SW or a little west of that point. He concurred with the author as to the extremely narrow track of the gale. In his own grounds about six poplar trees were broken down on the side of a plantation opposite to the direction of the wind, a large telegraph pole

in a direct line being also upset, the top blown off an elm, and limbs of trees 6 or 7 ins. in diameter strewn over a track about 50 ft. in length, whilst on a neighbouring plantation close by (within 100 ft.) trees were not injured. In the same narrow line, extended to a quarter of a mile distant, one elm tree of 24 ins. in diameter and a very large poplar were blown down. The leaf was nearly off both the elm and poplars.

Mr. CURTIS called attention to the fact that the hourly velocities recorded by anemometers during the gale, instead of being unusually high, were generally lower than are commonly reached in heavy gales of wind; the highest—at Holyhead and Aberdeen—being but a little over 70 miles in 60 minutes, whilst at Valencia it was less than 60, at Armagh only 24, at Stonyhurst 45, at Glasgow 30, and at Kew 45 miles ; yet at some of these places the damage done by the gale had been unusually great. The explanation of this lay in the fact that the instruments as they now exist are incapable of recording short squalls, which, in spite of their brevity, are yet very frequently the chief causes of the mischief done in gales. The trace of the Holyhead instrument might be described as a mass of such short gusts, and indeed it was one of the best examples of a squally wind he had met with. The use of these hourly velocities, instead of the *rates* during *short* intervals, could hardly fail to be misleading in judging the destructive power of a storm, no matter what formula might be used for finding their equivalent pressures. The wide difference between the table of relative wind pressures and velocities recently adopted by the Commission appointed subsequent to the Tay Bridge accident, and those hitherto in use, shows forcibly the amount of doubt which must attend the use of such a long time-unit as one hour.

Prof. ARCHIBALD said, with reference to the theoretical side of the question, Mr. Symons had remarked that no one yet knew the precise distinction between a so-called whirlwind and a cyclone or storm. It seemed to him that the ordinary nomenclature with regard to whirlwinds and storms required alteration ; hurricanes, tornados, storms and tempests being spoken of as if they were synonymous terms. In a recent work by Prof. Ferrel, of the United States Coast Survey, he divided atmospheric disturbances into cyclones and tornados. He thought it would be well to adopt this nomenclature, since there was a great difference between a tornado—which only occupied about 1000 ft. in width and whose course ran to 20 miles in length—and a cyclone, which, perhaps, was as many miles in diameter and ran half across the globe. According to Ferrel, the smaller cyclones did not even begin where the larger tornados ended, so that a great gulf lay between them. There was also found to be an important qualitative difference between these phenomena, since whereas the wind in the cylcone was a great deal affected by terrestrial rotation, so that (according to Ferrel's law) if the air moved from one place to another it deviated to the right of its course in whatever direction it was moving,—in the tornado, owing to its small horizontal extent, terrestrial rotation had no sensible effect on the motion of the air, and there was thus a specific difference between the two. Mr. Symons had correctly described the difference between the main features of a whirlwind, or—as he thought it should be termed—a tornado, and those of a cyclone. He spoke about the lifting power of the air in the former, and stated that the barometer might be 0·2 inch lower in the centre than on either side, which would perhaps give a lifting power to the air, in buildings over which it passed, of about 14 lbs. per square foot ; Ferrel, on the other hand, asserted that the lifting power was not merely to be measured by the difference of pressure between the exterior and interior parts of the tornado, but by the difference between the velocities of the gyrations in the upper and lower parts. The latter, since a tornado was more like a rotating column than a disk, being generally slower than those above, allowed the air to rush in and fill up the partial vacuum near the centre arising from the more rapid gyrations above. An upward velocity might thus be caused amounting to upwards of 30 métres per second, which would give a pressure of about 24½ lbs. per square foot. It seemed to him that, perhaps, the occurrence of certain "lanes" at Alnwick noticed by Mr. Symons might have been caused by what Ferrel had also suggested, viz. that tornados might exist in the middle of a cyclone, which would account for the sudden gusts and veering of the wind that frequently took place in the middle of cyclones. After, however, having made a short inspection of the position of those lanes on the chart, it seemed

that in most cases they lay in valleys, which generally ran in the direction of the wind, and as the wind in such valleys might thus acquire greater force from flowing in a sort of channel, he did not think that circumstance could be confidently cited in favour of the theory. He thought, however, that the present storm presented an unusually good opportunity for determining the direction which the wind made with the isobars at different distances from the centre, and also suggested the advisability of obtaining a large number of observations to find out the average angle which the wind made with the isobars. It appeared to him that this could not easily be done from the diagrams exhibited, in which the isobars were on one map and the winds on another. There seemed to be no doubt from the theory of cyclones, as given by Blanford and Ferrel, that the condition of the air which gives rise to these phenomena is mainly one in which the vertical temperature decrement over a certain district exceeds that over other surrounding districts. In such a case the first district is likely to become the centre of a cyclone; and since, from the observations on the top of Ben Nevis, it would appear that just before storms came there was relatively a much greater difference of temperature between the summit and the base than usual, this seemed to indicate that mountain observations might become very valuable in forecasting the weather, since if rapid temperature decrements were met with, bad weather might with some degree of confidence be expected. It might be advantageous if observations could be taken on Snowdon, or those already taken on the Puy-de-Dôme and Pic di Midi utilised. The present storm seemed to have been rather abnormal in becoming stronger over the British Isles than over the Atlantic, since, according to Hoffmeyer, cyclones as a rule develop more energy as they approach longitude 40° W than anywhere else.

Mr. Mawley thought that the very interesting account of this important storm which Mr. Symons had given them would prove a valuable addition to the long series by the same author, descriptive of nearly all the most atmospheric phenomena which had occurred in this country for many years past. He also thought that these different investigations would, if taken together, furnish a very fair amount of material for the study of those extremes of heat and cold, fog and storm, drought and heavy rains, &c., to which we in this climate were liable. That a better knowledge respecting one at least of these extremes was desirable, few would be disposed to question after reading through the long list of disasters, many of them preventable, which appeared in the appendices. And besides this, the "working up" of these exceptional phenomena was a matter of much importance to every meteorological observer, as tending to relieve the monotony of his daily duties, and also to impress him with a sense of the possible value of his observations, for he never knows at what moment he may be called upon to furnish his quota towards an investigation of national importance, which some unusual effort of nature may have rendered necessary. With regard to the storm in question, it had received so much attention and from so many experienced hands, that very little was left for an individual observer to say respecting it. In the neighbourhood of London the average strength of the wind was nearly the same as in the great January storm, but as in the one case the strongest gusts came from a precisely opposite point of the compass to what they did in the other, many objects which had successfully weathered the first of these gales were with ease overthrown by the fierce westerly blasts of the October one. The following are the hourly velocities recorded at Addiscombe, Croydon, between noon and midnight on each of these occasions:—

	January 18th.	October 14th.
Noon to 1 p.m.	34 miles	32 miles.
1 p.m. " 2 "	34 "	36 "
2 " " 3 "	33 "	35 "
3 " " 4 "	35 "	35 "
4 " " 5 "	33 "	35 "
5 " " 6 "	28 "	30 "
6 " " 7 "	22 "	22 "
7 " " 8 "	20 "	20 "
8 " " 9 "	15 "	19 "
9 " " 10 "	12 "	18 "
10 " " 11 "	13 "	15 "
11 " " midnight	15 "	13 "

During the October storm the wind was, if anything, as a rule stronger than in the January one. Respecting Mr. Symons's remarks as to the striking differences in the maximum hourly velocities recorded at Greenwich, Kew, and Croydon, he believed these were principally due to the differences in the height of the cups from the ground, as all three anemometers were otherwise almost equally well exposed.

Mr. Scott, referring to Prof. Archibald's remarks as to the force of the wind, said that he had been informed by the Duke of Northumberland that it was the blast of NW wind which blew down the majority of the 4,000 trees he had lost, and the lanes on the map exhibited showed these lanes pointing NW and SE. Sir T. Brassey also graphically described the appearance of this NW wind on the water before it struck the 'Sunbeam.' In London, as far as he could judge, the trees had gone down before a SW wind, in Ireland generally before a westerly, but when the depression had crossed the backbone of England in the north, the north-west wind struck down with great violence as soon as the air had free motion over the flat country. He was himself in the north-west of Ireland at Florence Court, during the gale, and he had watched this gust of NW wind with great interest, for he was in doubt whether or not he could travel during the day owing to the trees which would have fallen. The squall came on at about 7h. 15m. a.m. and lasted about half-an-hour, the air was filled with driving rain and spoondrift from Lough MacNean (distant about 3 miles to windward). It was this gust which did most damage. One house in particular, which was blown down, was standing at daylight and was down at 8 a.m. The lowest reading of the aneroid he had got was about 28·3 ins. at 5 a.m., at an elevation of 250 ft. The chart for 8 a.m. showed an elongated oval area at the centre, starting nearly E and W across southern Scotland. One of the observers for the Office, Capt. Barron of the S.S. 'Sultan,' was out about the middle of the North Sea, and he did not feel any exceptionally severe gale. As to the "lanes," he did not see that any proof of their being little tornados could be alleged; the trees blown down lay usually in the direction of the lane. The phenomenon was well-known in every great storm; he remembered its being recorded in the storm of Jan. 6th, 1839. Admiral FitzRoy (Weather Book, p. 265) mentions it as a frequent feature of hurricanes. In the present storm it had occurred not only at Alnwick, but in the woods in the Co. Sligo in Ireland. As to the rapidity of advance of the storm centre, this had been very great, and the only time he remembered its being exceeded of late years was in the storm of March 12th, 1876, of which he had published an account in the *Quarterly Journal*, at the request of Mr. Eaton, then President, and in which the velocity of translation over Germany exceeded 70 miles an hour. The two cases presented points of resemblance. In both an extensive depression lay over the south of Scandinavia, and the rapidly moving, very violent, storm was subsidiary to it. Dr. Köppen had recently pointed out that the greatest danger from subsidiary depressions was on the south-west side of existing depressions. Dr. Möller, in the June number of the *Zeitschrift für Meteorologie*, had endeavoured to account for the extraordinary rapidity of motion of these subsidiary depressions by the indraft of the air which rises at their centres towards the descending current in the rear of the extensive area of rarefaction existing in front. This was a point eminently deserving of investigation.

Capt. Toynbee said that in the severe hurricane experienced in the North Atlantic in August, 1873, and which was discussed by the Meteorological Office, a small cyclonic eddy was met by a steamer when passing near the centre of the hurricane.

Mr. Rostron described the way the storm began at Cromer, on the east coast. He said that the centre of the depression being over the south of Scotland, as might be expected the extreme depression at Cromer was lower, and the force of the storm greater than it was in London. On the Thursday evening, after a very fine morning but dull afternoon, at about 10 p.m., the wind shifted round from the NW, and his aneroid barometer began to go down. Rain came on from the SE, from which quarter it blew hard all night. Next morning at 7.30 a.m. he found that the barometer had been falling all night, and was at 29·0 ins.; by 8 a.m. it had gone down another half tenth of an inch; this agreed exactly with the Fishery Barometer at the coast guard station. Both continued to fall until 11 a.m., when they read about 28·70 ins., and so they remained until about 4 p.m. The wind,

which was from the SE to SSE all night, at 8 a.m. (the air being very warm) shifted and blew very hard from the SW; it however rapidly veered to W, and from 9 a.m. until 4 p.m. the sea was covered with spoondrift. The greatest destruction of trees took place after the wind veered to the NW, and although the barometer continued to be comparatively steady at 28·70 ins., there was a slight depression during a tremendous squall between 4 and 5 p.m., and he believed the lowest point reached was during this squall, and just before the wind got to the NW, at about 5 p.m.; from that time until 7 p.m. the wind blew with its greatest violence. It was during these two hours that most of the damage was done. The strongest trees, such as oak, beech, and ash, suffered the most.

Mr. SYMONS, in replying to Mr. Peggs' remarks as to the enormous difference in the horizontal motion as recorded at different stations, said that each space in the diagram of anemometric data which was exhibited represented the total horizontal motion per hour by some one anemometer. Hence it would be seen that the total horizontal motions agreed no better than the extremes which he had already quoted, and therefore whether the extreme or mean velocities or the pressures were taken in each case, differences were obtained which he could not help thinking were almost solely due to the position of the anemometers; and until the anemometers were reasonably identical in position, as well as in construction, he did not think there was much use in comparing them. He approved of Mr. Peggs' suggestion as to the treatment of the subject by delegates, and said that that plan had been tried by the Society on two occasions with respect to Phenological Phenomena and to Lightning Conductors. With reference to Mr. Dines's remark, he had not very long since referred to the Report of the Jury on the International Exhibition of 1851. It appeared that the Society of Arts were at that time anxious to ascertain whether the Exhibition would be blown away or not. Sir Joseph Paxton was asked about it, and a discussion took place at the Society of Arts, when it was stated that the maximum to be provided for was 22 lbs. per square foot, which bore out Mr. Dines's remarks upon the subject. He considered that sufficient care was not taken to verify the indications, springs and arrangements of the pressure anemometer. This could be done at but slight expense, and the late Mr. Cator made it a regular practice to verify his anemometer by hanging weights to the back. The maximum pressure which he ever got was 30 lbs. per square foot, thus agreeing pretty nearly with some of the other facts. With respect to railway carriages, he thought it a peculiar circumstance that a Commission virtually appointed by the Railway Department, Board of Trade, to study the effect of wind upon railway structures, had not determined the pressure involved in blowing over a set of carriages. With regard to Prof. Archibald's observations as to the isobars being on one map and the wind on another, the facts were separated for two reasons. First, the paper was not a theoretical one; he had merely laid down facts, and had not assumed that there was any relation between the isobars and the direction of the wind. The next reason was that if the direction of the wind and the isobars had been put on one map, the arrangement would have been too crowded to be well followed; but he hoped some one else would put them together. He agreed with Mr. Scott as to the lanes being lanes, and not whirlwinds; but thought there was no doubt whatever that the stream of air swept onwards as if one had sent a cart-wheel or a steam roller right across the country.

Mr. PEGGS said with reference to the remarks made by Mr. Dines on the strength of the mortar joint, it seemed to him (Mr. Peggs) that the oscillation, in the case of the chimney shafts and stacks of chimneys, would have already broken the mortar joint at the point where the chimney was about to turn over. With reference to the remarks of Mr. Law, as to the cylindrical surface being half the square surface, he (Mr. Peggs) had taken that into consideration in the calculation. The angle at which the wind struck the surface had also been taken into consideration. Mr. Latham had remarked about the chimney shafts not breaking at the weakest point. The lines of fractures shown on the diagram were the actual lines along which the structures actually broke, and of course these were the lines we must deal with in making calculations.

Mr. WHIPPLE remarked, through the Secretary, that he had observed during the gale the extreme brevity of the gusts of wind; for standing watch in hand beside the anemograph and reading off the graduations on a circle, each division of which indicated the passage of a tenth of a mile of wind, he found that the

rate of the wind was never excessive for more than a few seconds, possibly three, at a time; for those short intervals it was not possible to determine accurately the true rate, it might be estimated at approaching 100 miles per hour. Taking the whole minutes the rate actually noted when the storm was at its highest, at noon, did not exceed one mile, or 60 miles per hour. He would also suggest to observers not provided with self-registering barographs that they should if possible, during violent storms, read their barometers or aneroids at the instant they observe their windows rattle violently. He had noticed that this phenomenon usually occurred at the turning-point of the storm, being the effect of the sudden expansion of the air in the building, which has been alluded to already as the cause of the lifting of the roofs off empty buildings.

Meteorology of Mozufferpore, Tirhoot, 1880. By C. N. Pearson, F.M.S.

[Read November 16th, 1881.]

January was rather mild for the season, with frequent fogs in the mornings, and a damper air than usual, but without rain, which was rather wanted for the rubbi crop at the close of the month.

February was unusually unsettled between the 5th and 19th. Good rain fell on the 9th, 10th, 11th, and 16th, with advantage to all crops, except wheat, to which it caused partial rust. The weather was unusually cool, and the total fall of rain 1·56 in.

March was distinguished by the constancy with which easterly winds prevailed from the 9th to the end. The effect was to blight the mango crop, of which there had been unusual promise. The day temperature of this month was lower than usual, but the nights, owing to the easterly winds, were unusually warm.

April was seasonable, and there were some strong west winds during the first half of the month, that raised the temperature to the maximum of the year, viz. 101° on the 12th. This month, like April 1879, passed without rain, but the temperature was much more moderate than in that year.

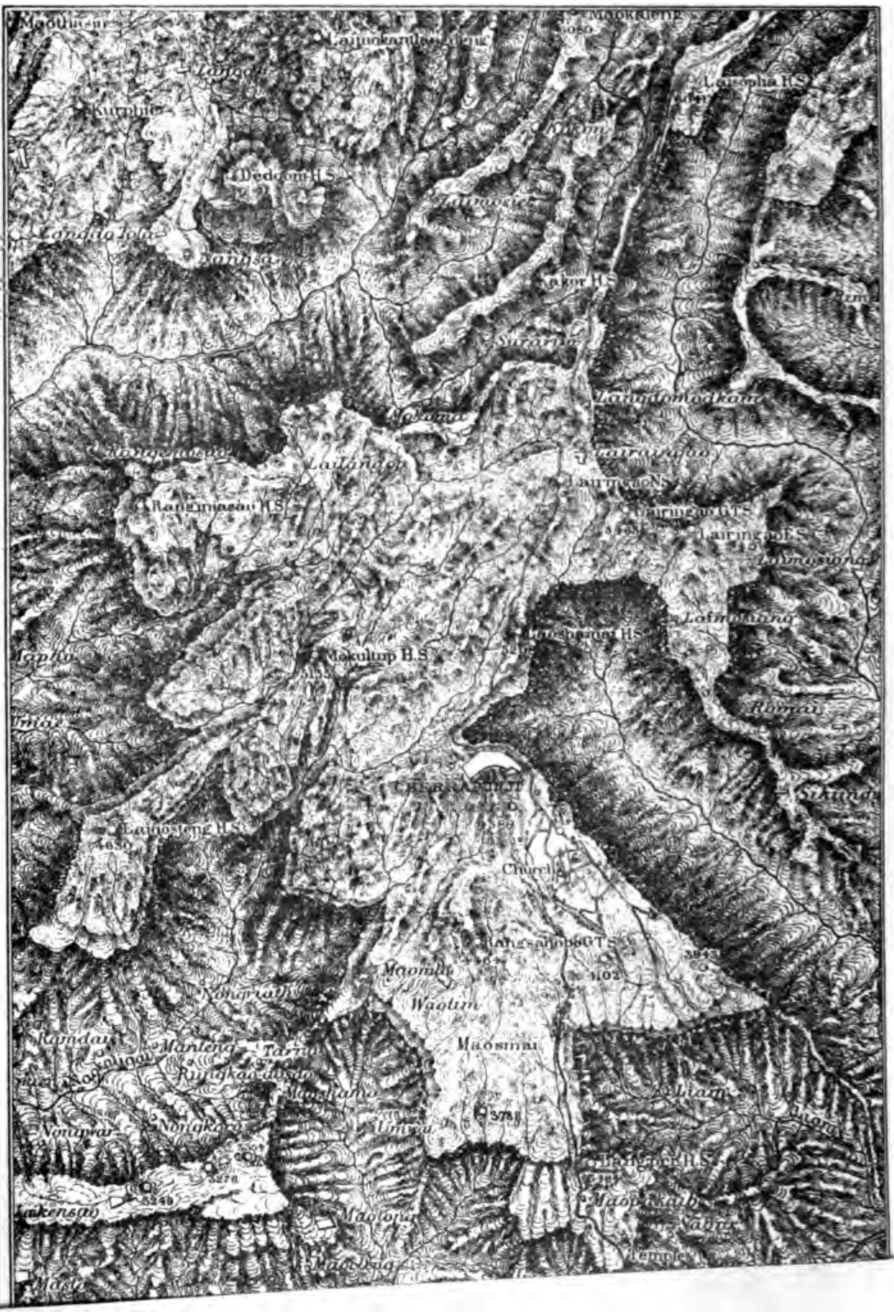
May was in all respects seasonable; the temperature was moderate, never exceeding 100°, which was only once reached, on the 29th. There was a fine fall of rain, 1·66 in. on the 9th, and another 0·98 in. on the 25th, besides other slight showers. The total rainfall was 2·88 ins.

The weather in *June* was hot, but there were no extremes, the maximum temperature being 99° on the 2nd. Showers fell at intervals, but the aggregate rainfall was only 2·59 ins. less than in May, and much below the average; the only heavy fall was 1·82 in., accompanying a thunderstorm, on the 20th. In June 1879, the rainfall was 17·14 ins.

The first half of *July* was hot, and the rainfall scanty, but on and after the 18th it was heavy and continuous, and the total rainfall for the month was 15·62 ins.

In *August* the rainfall was also heavy and continuous, especially during the first half of the month. The direction of the wind was more westerly

MAP SHOWING THE CHERRAPUNJI DISTRICT.



than usual, and in the north-west provinces drought prevailed, which gave rise to partial scarcity.

September was a remarkable month in many respects. Here it was marked by unusually fine weather; indeed, it was the driest September I have yet registered, with a rainfall of only 1·50 in., but the showers, though slight, were well distributed, and following the heavy rains of July and August, the partial cessation was rather beneficial than otherwise. This month will be ever memorable for the terrible landslip that occurred at Nanei Tal on the 18th. The rainfall at that station between the 16th and 19th was enormous; 32 inches was, I believe, registered during those three days, but some accounts represent it as even higher. Parts of the Punjab and of the NW Provinces had also unusually heavy rain with great floods at this time, but the greater part of the country was not visited by the rain, and still suffered from drought.

October was warm, and showers fell on the 1st, 3rd, 16th, and 19th, the aggregate fall being 1·42 in.; the showers being well distributed, the rice crops scarcely suffered at all, indeed the crop on the lowlands was splendid.

The weather in *November* was warm till the 20th, when a moderate general fall of rain introduced the regular cold weather. This fall of rain (0·28 in. here) was general throughout Northern India on the 19th and 20th; heavy snow fell at the hill stations; the rain was extremely beneficial in those parts that were suffering from drought.

December was seasonable, with a very slight shower, 0·01 in., on the 11th.

The year was, taken as a whole, one of cheapness and plenty throughout India. The aggregate rainfall was 41·67 ins., being somewhat below the average, out of which upwards of 30 inches fell between July 18th and August 31st.

THE RAINFALL OF CHERRAPUNJI. By JOHN ELIOT, M.A., Professor of Physical Science, Presidency College, Calcutta, and Meteorological Reporter to the Government of Bengal. (Plate XI.)

[Read December 21st, 1881.]

I HAVE the honour to submit for the information of the Society all the data of the rainfall at Cherrapunji, in Assam, which has been accumulated by the Indian and Bengal Meteorological Departments.

Cherrapunji is notorious for its excessive rainfall, larger in amount I believe than at any other place so far as is known. This excessive rainfall is due to a combination of favourable conditions, which are stated below.

The data will, I trust, be regarded as of some value as illustrating rather fully the character of tropical rainfall under exceptionally favourable circumstances, and such as, I may add, occasionally obtain in the Bay of Bengal, giving rise to the deluge of rain which forms one of the most prominent features of the cyclones of that region.

The data will also be useful as giving precise and fairly accurate averages for the rainfall at Cherrapunji, in place of the somewhat vague statements respecting it which are usually given in meteorological works and periodicals. They will also be of use to those meteorologists who believe that the study of abnormal and exaggerated atmospheric conditions is as valuable and instructive as the preparation and comparison of normal or average atmospheric conditions.

Cherrapunji is a small Indian station situated in the south-west of Assam, on a small plateau forming the summit of one of the spurs of the Khasia hills. These hills, which rise on the south with exceeding abruptness, have the Bengal plains and low lands at their base. Cherrapunji stands on the summit of one of these hills, at an elevation of about 4,100 feet. The hill on which it is situated rises precipitously from the low lands of Cachar and Sylhet, which are barely 100 feet above mean sea-level. (Plate XI.)

During the South-west Monsoon the lower atmospheric current advancing across the coast of Bengal (and which forms part of the general circulation between India and Central Asia and the Indian Ocean) has a direction varying between SSW and SE in Lower and Central Bengal. It thus advances almost directly towards the hills of Western Assam.

The mountain ranges cause a very considerable deflection of the current. One portion of air is forced upwards as an ascending current, with a velocity directly dependent upon the strength of the current in the rear, and upon other conditions which need not be enumerated.

The rapid diminution of temperature which accompanies expansion due to ascensional movement of air, is usually followed by rapid condensation in the case of a moist current, such as the South-west Monsoon current. The complex actions that take place, due to the combined changes of ascensional motion and condensation of aqueous vapour, need not be further considered beyond their general bearing on an important question.

If the usual explanation of the excessive rainfall at Cherrapunji is the correct one, the data given in this paper supply a rough measure of the effect of ascensional motion of the atmosphere in producing a general rise to rainfall.

The normal annual rainfall in Cachar (117·11 ins.) and in the plains of Northern Bengal is about 100 ins. The average annual rainfall of Cherrapunji is 498 ins., that is, 398 ins. in excess of what it is at the foot of the hills on which it is situated. The rainfall at Cherrapunji is not due to any abnormal local conditions of atmospheric pressure, air movement, &c., but simply and solely owing to the presence of a vast mechanical obstruction which converts horizontal air motion into vertical air motion.

The excess, therefore, speaking generally, represents the additional rainfall due to the sudden upward deflection of the South-western Monsoon current in North-eastern Bengal and South-western Bengal through an elevation of over 4,000 feet.

The preceding remarks may perhaps appear to be somewhat trite. As, however, the ascensional movement of the atmosphere is the chief factor in

determining the continuance of, as well as the origin of this, the heavy rainfall which always accompanies and occurs during the cyclonic storms of the Bay of Bengal, it seems to me that every action which may initiate and continue ascensional movement should be fully recognised and studied.

A full description of the station of Cherrapunji is given in Dr. Hooker's *Himalayan Journal*, Vol. II. pp. 272-88. The following is his account of the character of the rainfall at Cherrapunji as witnessed by himself:—

"The climate of Khasia is remarkable for the excessive rainfall. Attention was first drawn to this by Mr. Yule, who stated, that in the month of August, 1841, 264 ins. fell, or 22 feet; and that during five successive days, 30 ins. fell in every twenty-four hours! Dr. Thomson and I also recorded 30 ins. in one day and night, and during the seven months of our stay upwards of 500 ins. fell, so that the total annual fall perhaps greatly exceeded 600 ins., or fifty feet, which has been registered in succeeding years! From April, 1849, to April, 1850, 502 ins. (forty-two feet) fell. This unparalleled amount is attributable to the abruptness of the mountains which face the Bay of Bengal, from which they are separated by 200 miles of Jheels and Sunderbunds.

"This fall is very local: at Silhet, not thirty miles further south, it is under 100 ins.; at Ganhati, north of the Khasia in Assam, it is about 80 ins.; and even on the hills, twenty miles inland from Churra itself, the fall is reduced to 200 ins. At the Churra station, the distribution of the rain is very local; my gauges, though registering the same amount when placed beside a good one in the station, when removed half a mile, received a widely different quantity, though the different gauges gave nearly the same mean amount at the end of each whole month."

The following description of the station and of the character of the rainfall is given in Mr. Blanford's *Indian Meteorologist's 'Vade Mecum,'* Part II.:—

"The highest precipitation occurs when a saturated current of air at a high temperature is met by a hill range running athwart its course; and the steeper the slope, the greater is the local precipitation. Cherrapunji in the Khasi hills, long renowned as having the highest recorded rainfall in the world, is a remarkable illustration of the combination of these favouring conditions. The Khasi hills rise abruptly from the *jhils* of Silhet, which being but a few feet above sea-level, and receiving the copious drainage of the hills that surround Cachar and Silhet, present, during the rainy season, a broad sheet of water, from which emerge a few villages built on mounds and the low ridges locally termed *tilas*. Over this low inundated tract sweeps the south-west monsoon from the Bay of Bengal; and, meeting the Khasi hills, is abruptly driven up to a height of 4,000 feet before it resumes its course towards Upper Assam and the Eastern Himalaya. These circumstances alone suffice to produce an exceptionally heavy rainfall along the face of the range. But Cherrapunji is in some respects exceptional, even in this highly humid region. It stands on a little plateau of thick-bedded sandstones, bounded on two sides by precipices of 2,000 feet

sheer descent, which close in gorges, debouching southwards on the plains. The south-west wind blows up these as well as on the southern face of the general scarp; and, having reached the heads of the gorges, ascends vertically. Thus Cherrapunji is surrounded, or nearly so, by vertically ascending currents of saturated air; the dynamic cooling of which is the cause of the enormous precipitation which has made this place famous. It is almost certain that the annual average varies greatly in different parts of the station, although the whole plateau does not cover much more than a couple of square miles. Some of the earlier registers, which were kept at sites near the edges of the plateau, show a higher precipitation than those kept in recent years at houses nearer its centre."

The tables on pages 45-50, give the daily rainfall recorded at Cherrapunji during the summer months from the year 1865 to the present time. During the years 1865 to 1869, the rainfall observations were taken by the staff of the Topographical Survey Party, No. 6, under Captain Godwin Austin, who was at that time engaged in surveying the Khasi and Garo Hills. This staff when not in camp also took a series of daily observations of the aneroid barometer, thermometers, wind, &c., during this period. These are not continuous, and give a broken and imperfect record of the weather for only three years, and are hence not sufficient to enable the average values of the elements of meteorological observation to be determined. When the survey party finished their work in the Khasi Hills and the staff was withdrawn from Cherrapunji, the meteorological observations were discontinued. The rainfall was noted as usual at the smaller Indian stations. The rain-gauge is kept near one of the Government offices, and the amount of the rainfall recorded by a subordinate under the superintendence of a Government officer. The rainfall returns obtained in this manner are, as a matter of experience, fairly trustworthy and accurate.

I have added another table, p. 51, giving not merely the monthly rainfall for each month since January, 1869, but also for several years previous. This information was collected by the medical department before meteorological departments were established in India, and has recently been made over by that department to the Meteorological Office in Calcutta. As I have not been able to learn the conditions under which the rainfall returns furnished by the medical department were made, I have not included them in the brief discussion of the rainfall at Cherrapunji.

If the record of the rainfall at Cherrapunji in the years 1860 and 1861, as given in the records of the medical department, could be unhesitatingly accepted, it would be interesting to inquire into the meteorological conditions of these two years, in the former of which a rainfall of 699·78 ins. was registered, and in the latter a rainfall of 905·12 ins. The rainfall returns of Calcutta and other Bengal stations show that the rains were considerably heavier than usual; but the information at my disposal is too limited to throw any light upon the unprecedented heavy rainfall of 1862.

DAILY RAINFALL AT CHERRAPUNJI, APRIL 1871-1880.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
1871	0·88	..	1·10	1·40	0·06	4·41	0·18	0·03	0·22	4·33	0·23	2·03	0·37	0·29	1·08	0·04
1872	0·40	0·31	..	0·04	..	..	..	0·37	..	..	0·03	..	..	..	..	..
1873	..	0·19	0·05	0·74	0·82	0·16	..	..	..	0·74	0·05	..	1·28	2·21	1·06	0·25
1874	0·73	1·36	0·32	0·50	2·31	0·72	..	0·93	0·33	..	0·21	..	..	..	..	2·43
1875	1·00	0·07	0·56	..	0·76	0·73	2·96	0·23	0·83	0·68	4·91	2·26	1·17	7·55	0·93	0·85
1876	1·40	..	..	0·40	..	..	..	..	..	0·03	..	0·01	0·65	0·04	0·20	0·07
1877	0·43	..	0·65	..	..	0·71	..	.	0·23	1·40	0·62	0·10	0·30	0·30	1·35	..
1878	0·83	2·24	0·63	1·72	2·39	..	1·29	0·11	1·61	0·22	0·16	0·12	3·75	0·91	..	0·54
1879	..	..	..	..	..	..	..	..	..	...	..	0·01	0·38	..	..	..
1880	..	..	..	..	..	..	0·97	2·84	3·72	5·68	12·32	0·77	3·22	6·42	6·95	2·76

	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total.
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
1871	0·74	0·15	..	0·03	..	0·58	..	0·87	..	0·55	0·41	..	0·38	..	20·36
1872	..	1·65	0·44	0·40	0·15	0·41	0·46	0·13	0·68	12·43	6·03	1·46	1·74	1·82	28·95
1873	1·38	3·31	0·98	0·26	0·03	..	0·30	0·50	0·06	1·35	1·81	..	0·41	..	17·94
1874	4·45	2·26	1·36	2·98	..	0·93	3·72	0·11	0·67	..	0·77	0·71	..	0·53	28·33
1875	0·70	0·75	3·60	11·00	0·28	..	..	0·15	0·15	1·32	1·58	1·07	0·05	8·21	54·35
1876	..	1·72	0·07	0·18	0·02	..	1·12	6·11	8·20	4·38	7·12	0·15	0·02	0·02	31·91
1877	..	0·05	..	0·72	..	..	0·10	..	1·00	3·40	0·30	0·10	..	..	11·76
1878	..	0·23	..	..	..	0·42	1·30	0·20	0·58	..	..	0·68	..	0·31	20·24
1879	..	..	2·75	0·18	0·17	0·97	1·00	0·99	0·60	2·56	0·10	0·48	0·64	0·03	10·86
1880	..	..	..	..	0·54	1·57	3·84	1·42	1·33	..	1·22	0·07	0·16	0·28	56·08

The average monthly and annual rainfall is given below (as determined from the rainfall of the period 1865-1880) :—

Month.	Average Rainfall.
	ins.
January	0·76
February	2·76
March	8·79
April	30·90
May...	51·48
June	115·88
July...	130·84
August	79·62
September	56·10
October	13·65
November	2·23
December	0·28
Average Annual Rainfall ...	493·19

The means, it may be noted, are practically the same as those given in Mr. Blanford's *Report on the Meteorology of India for* 1878, and are obtained from all the monthly amounts given in Table II. (p. 51.)

The rainfall of the cold weather months, November to the end of February, during which northerly land winds prevail in Bengal, is very small, averaging barely 5 ins. Local sea winds set in along the coast of Bengal in the month

DAILY RAINFALL AT CHERRAPUNJI, MAY 1865-1880.

Date.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	1
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	I
1865	—	—	—	—	—	—	—	—	—	5·72	5·00	0·39	0·29	..	..	4
1866	2·29	..	..	..	..	..	1·09	1·09	2·29	0·69	1·79	..	..	0·79	0·40	0
1867	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	-
1868	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	-
1869	0·10	0·80	..	0·20	0·20	..	0·50	1·50	4·33	5·00	1·45	..	0·35	..	..	8
1870	..	..	..	..	..	..	..	.	..	..	..	..	..	..	..	.
1871	0·93	..	..	..	..	..	..	1·03	0·27	1·32	0·85	0·51	0·72	0·11	..	.
1872	0·60	2·21	0·18	0·61	1·11	5·05	1·50	0·32	0·18	5·00	2·06	0·08	2·03	1·25	2·93	.
1873	0·13	0·07	2·91	0·11	..	0·03	..	1·54	0·06	0·54	..	0·86	0·46	4·00	0·19	.
1874	0·03	1·15	0·50	4·08	6·04	2·76	4·13	5·74	3·55	5·00	5·05	3·86	0·06	3·31	9·20	9
1875	2·98	..	0·35	0·04	..	0·78	..	0·13	2·04	0·18	0·04	1·25	0·98	3·05	1·94	0
1876	2·41	6·92	10·43	7·95	7·20	0·82	2·64	0·52	0·14	0·40	0·45	1·41	0·30	1·14	1·03	1
1877	0·25	0·30	0·30	0·65	..	1·20	1·85	2·30	0·10	0·25	0·80	0·60	..	..	..	0
1878	..	0·97	0·58	1·79	..	0·23	0·98	0·67	3·63	...	0·35	0·06	..	..	1·68	0
1879	..	0·49	0·68	4·67	0·65	0·33	1·03	2·94	5·13	4·80	11·81	8·71	4·07	1·12	0·62	2
1880	..	..	1·40	0·72	0·20	..	..	..	..	3·74	1·68	0·43	0·52	0·73	0·21	.

Date.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total.
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In
1865	0·85	..	..	..	..	..	..	1·87	2·00	1·39	..	3·64	1·43	3·36	..	—
1866	0·53	0·41	0·52	..	0·68	..	..	0·79	1·40	0·45	..	0·42	0·80	2·61	1·54	20
1867	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1868	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1869	14·00	5·25	7·25	9·00	0·30	2·90	0·55	9·35	9·40	2·50	9·50	2·15	2·00	3·35	4·55	104
1870	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1871	..	..	3·29	3·65	0·70	..	0·07	5·72	5·83	4·32	3·09	0·25	0·67	..	..	33
1872	2·20	0·04	2·30	0·50	..	..	..	0·61	..	1·88	0·20	0·07	..	..	1·70	34
1873	..	..	..	..	..	..	0·57	0·50	..	0·04	..	..	0·05	0·50	0·80	13
1874	7·23	9·79	1·54	0·96	1·28	0·30	2·53	0·15	0·46	2·50	5·00	0·38	..	..	—	96
1875	..	0·31	..	0·02	..	0·01	..	..	0·23	0·10	1·42	0·54	1·20	1·22	3·75	22
1876	3·01	..	0·30	1·52	..	0·02	..	0·22	0·17	1·10	0·92	0·70	0·30	0·03	..	53
1877	0·10	1·64	2·10	6·60	4·80	2·85	0·85	4·30	0·80	1·10	..	..	0·15	0·90	..	35
1878	0·14	0·58	0·87	0·07	0·03	0·26	1·38	0·83	0·08	0·48	0·73	1·27	0·76	0·07	..	19
1879	7·89	3·70	0·53	2·82	2·25	0·28	0·52	2·33	3·72	3·23	2·49	1·61	0·66	0·41	3·20	84
1880	0·33	1·50	..	..	..	5·61	2·81	0·30	1·12	1·02	0·16	..	..	..	2·20	24

of March, and increase in intensity and extend their influence to a greater distance inland during the months of April and May. During this period the rainfall at Cherrapunji rapidly increases in amount. Early in the month of June the local sea winds of Bengal are converted into the general and continuous winds of the South-west Monsoon. The average strength of the South-west Monsoon sea winds at the earth's surface is not greater than that of the local sea breezes which precede them. They, however, sweep over a very much greater extent of water surface, and hence bring up a much more extensive, continuous, and uniform supply of aqueous vapour. Hence the rainfall at Cherrapunji increases rapidly in June, and is at its maximum in July. It diminishes slowly during the months of August and September, and very rapidly in October, during which month the transition from southerly to northerly winds in the lower atmospheric strata usually takes place in Northern India.

The following table is drawn up to show as far as possible the connection

DAILY RAINFALL AT CHERRAPUNJI, JUNE 1865-1880.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
2·47	6·86	8·31	2·52	7·72	0·37	1·99	6·65	9·09	1·00	4·17	1·41	1·04	5·17	0·20	3·57
0·29	..	..	0·42	1·14	3·44	9·50	7·90	1·12	4·00	0·29	..	..	0·59	..	0·40
..	0·40	0·01	..	1·90	2·90	0·05	..	..	..	0·40	..	1·20	0·10	3·80	3·90
..	..	..	..	..	..	1·00	3·40	3·60	13·80	6·90	13·90	5·00	3·40	3·45	4·35
1·50	5·90	1·10	0·95	0·60	..	..	1·05	13·75	11·00	12·00	7·80	7·15	..	0·50	5·25
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0·12	0·55	0·59	0·08	..	..	1·36	2·40	13·62	9·34	2·01	1·21	1·61	1·72	0·45	7·09
5·55	0·40	3·02	10·25	8·09	7·09	2·35	2·18	1·11	..	..	0·46	1·50	2·31	0·56	0·09
0·34	0·30	8·71	0·80	3·18	2·81	2·12	9·20	4·36	6·44	5·57	11·92	1·22	2·00	6·00	2·46
—	—	—	—	—	—	..	2·17	0·17	4·00	7·28	3·62	0·16	..	0·46	1·47
2·41	0·03	0·07	0·04	3·00	4·08	5·28	1·80	1·20	14·04	1·00	3·64	21·00	21·14	10·14	9·42
0·16	1·20	..	0·16	0·62	3·10	2·40	4·40	6·70	7·32	5·58	30·45	7·75	40·80	22·84	12·30
0·20	0·85	..	..	..	1·75	9·82	4·32	6·09	6·23	3·20	0·54	3·02	2·91	0·32	0·41
..	..	0·28	6·14	3·87	8·59	0·58	0·35	0·89	3·95	1·08	0·02	..	..	0·30	0·60
7·34	17·35	18·67	5·46	6·66	8·63	0·20	..	0·78	..	0·02	0·72	..	6·42	3·54	10·93
..	2·48	4·53	9·06	10·98	4·38	15·73	5·23	0·98	0·74	0·37	3·14	5·35	11·20	13·43	7·91

	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total.
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
65	2·88	7·37	12·35	12·61	5·14	13·53	8·75	5·63	5·98	3·91	..	..	..	1·05	141·74
66	0·38	2·59	5·29	2·60	1·49	2·60	1·45	2·50	20·25	9·70	5·20	1·30	5·30	4·95	94·69
67	2·10	0·50	0·50	0·20	0·30	4·70	6·40	6·30	8·75	8·20	20·25	23·00	6·50	..	102·36
68	6·50	..	9·60	7·10	16·40	5·25	3·00	..	0·95	2·55	3·70	1·90	2·80	7·60	126·15
69	1·55	0·50	0·50	..	..	6·40	6·00	1·60	1·60	..	7·10	2·70	6·20	4·50	107·20
70	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
71	3·39	3·76	1·42	0·24	0·65	0·64	0·34	0·11	1·16	2·36	2·85	3·76	10·67	4·58	78·08
72	6·76	24·00	16·36	4·31	..	0·98	0·83	0·21	1·66	0·61	0·97	..	..	..	101·65
73	1·10	3·76	3·09	7·89	0·29	0·30	0·16	0·04	0·38	4·00	0·33	0·05	..	..	88·82
74	0·88	2·11	5·53	6·77	2·50	0·50	3·20	1·20	6·65	3·85	4·59	2·76	1·34	1·69	..
75	0·34	1·40	3·10	3·40	2·74	1·90	2·20	4·00	0·45	1·04	..	5·00	2·30	8·00	134·16
76	1·31	0·40	..	1·70	8·56	6·20	6·93	4·71	0·05	2·10	2·71	1·10	0·04	3·51	184·80
77	..	0·24	0·12	..	..	0·52	0·13	..	0·32	..	1·13	1·54	1·42	0·51	45·59
78	4·87	5·43	17·80	1·32	12·30	2·25	7·18	6·89	2·30	9·30	9·78	17·04	6·67	6·23	136·01
79	1·20	4·91	1·73	10·50	5·90	9·86	1·90	8·94	3·72	1·76	2·13	1·41	3·36	0·76	134·80
80	2·55	9·32	3·58	0·81	2·52	0·43	1·80	2·17	..	..	0·50	..	..	2·54	121·73

and relation between the amount of the annual rainfall at Cherrapunji and the character of the monsoon rains in Bengal :—

Year.	Variation from Mean Annual Rainfall at Cherrapunji.	General Character of Monsoon Rains in Bengal.
	ins.	
1865	+10·91	Rainfall generally slightly above average.
1866	−123·33	Generally normal in distribution.
1867	−142·59	Generally normal in amount and distribution.
1868	−18·12	Above average in Lower Bengal. Average in Northern Bengal.
1869	+65·83	Below average generally in Bengal.
1870	?	Excessive Rainfall in Northern Bengal.

DAILY RAINFALL AT CHERRAPUNJI, JULY 1865-1880.

Date.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
1865	2.10	1.73	0.50	1.50	1.77	3.40	3.59	3.17	4.87	8.81	16.19	3.06	1.89	1.08	0.62
1866	2.70	2.00	0.50	0.60	1.20	1.20	2.50	6.50	8.70	6.20	1.00	0.50	3.50	1.50	5.00
1867	..	0.65	1.70	2.30	1.70	12.75	7.00	6.60	4.25	6.00	8.05	10.40	7.20	4.60	..
1868	11.00	19.00	3.80	4.25	0.60	..	3.00	8.80	14.70	14.55	6.00	6.65	7.85	4.50	4.20
1869	4.25	13.50	5.40	6.90	6.80	2.70	2.50	3.75	7.20	5.90	6.50	5.35	0.90	3.20	4.10
1870	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1871	2.35	1.93	0.68	1.26	0.76	0.52	3.76	0.27	1.67	0.21	4.02	1.75	5.90	10.79	11.00
1872	..	7.53	7.50	10.50	19.79	8.36	6.77	11.01	0.47	1.00	..	0.37	0.07	..	0.05
1873	1.30	1.84	0.81	4.21	2.14	2.03	1.62	2.02	4.61	2.93	5.00	2.17	2.25	1.17	0.37
1874	0.27	1.00	8.97	6.38	18.45	20.50	11.55	11.32	4.41	7.91	7.72	1.36	0.41	4.31	5.91
1875	—	—	—	—	—	—	—	—	0.66	4.27	6.33	2.03	0.77	0.53	0.42
1876	0.18	0.64	2.10	3.26	10.30	9.12	1.00	0.05	0.12	2.21	2.33	1.60	1.98	1.68	1.83
1877	0.27	4.88	1.80	2.47	0.41	5.43	2.87	0.26	..	..	..	0.54	0.78	1.07	0.98
1878	9.94	9.75	7.68	3.54	5.70	3.83	4.45	6.74	7.70	10.34	10.86	0.52	2.20	8.63	3.11
1879	3.95	3.82	5.07	3.42	2.24	1.90	5.15	8.10	6.73	4.58	6.60	1.02	8.12	7.24	8.15
1880	7.45	0.80	3.18	4.14	1.90	1.93	1.42	3.20	0.31	0.56	0.70	1.44	0.45	0.08	0.43

Date.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
1865	5.30	4.14	3.09	3.89	12.16	16.47	13.40	16.50	15.15	10.13	10.99	15.75	17.84	5.00	2.85
1866	7.00	9.70	4.50	1.50	2.60	4.60	6.50	10.00	10.00	10.70	2.70	1.60	2.20	..	..
1867	0.10	0.80	1.55	0.70	0.50	2.10	3.20	3.40	3.10	2.70	5.20	4.00	11.10	10.40	8.70
1868	3.70	3.80	6.30	3.30	0.45	3.60	9.05	8.25	10.15	4.80	2.40	4.00	0.15	0.16	0.67
1869	0.50	..	0.65	..	0.37	0.85	0.50	0.72	0.53	1.20	2.40	0.25	..	6.50	6.60
1870	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1871	0.66	0.04	0.84	2.22	2.50	4.27	3.90	3.00	2.80	0.02	0.25	0.69	..	2.23	2.38
1872	0.24	0.05	0.04	0.59	1.82	0.11	0.21	3.54	2.82	4.44	4.49	4.24	13.53	13.62	5.89
1873	..	..	..	0.82	0.18	..	2.51	5.55	2.59	5.45	4.70	5.47	5.65	2.73	0.67
1874	..	..	..	..	..	0.06	0.67	0.18	0.12	0.74	..	0.02	0.87	1.62	0.35
1875	0.30	..	..	..	2.19	2.74	1.05	..	1.14	2.08	7.36	6.42	16.76	3.88	5.20
1876	2.18	1.91	4.31	1.14	6.25	3.44	0.21	0.91	1.30	2.57	3.16	0.02	2.08	3.80	5.88
1877	5.39	8.91	4.68	8.05	6.20	16.05	0.14	..	..	1.91	3.80	11.87	9.64	2.62	4.30
1878	0.81	5.75	6.90	15.92	9.80	4.80	..	1.85	3.72	0.27	1.24	0.80	0.76	2.34	0.30
1879	4.70	1.91	4.18	7.70	0.51	..	0.14	..	1.24	2.05	0.95	0.15	0.62	0.25	..
1880	2.16	4.68	9.16	5.08	0.66	0.94	4.16	3.02	11.14	11.94	8.14	2.20	1.93	0.51	0.07

Year.	Variation from Mean Annual Rainfall at Cherrapunji.	General Character of Monsoon Rains in Bengal.
	ins.	
1871	−171.74	Rainfall deficient in amount in Eastern Bengal.
1872	−15.36	Generally slightly below average over all Bengal.
1873	−210.19	Very deficient in Northern India, especially in Behar and Northern Bengal.
1874	−70.64	Deficient in Eastern Bengal.
1875	−84.61	Deficient in amount in Eastern and Northern Bengal.
1876	−23.84	Irregular in distribution, but generally slightly above average except in Assam, where it was under the average.

DAILY RAINFALL AT CHERRAPUNJI, AUGUST 1865-1880.

2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
..	..	..	..	0·53	..	3·88	4·48	8·80	7·80	4·29	1·40	..	5·06	1·50
5·20	..	2·80	..*	3·90	0·90	0·10	0·50	..	0·50	..*	2·50	1·30	0·50	0·30
0·90	1·65	2·48	2·50	3·00	2·10	5·00	1·85	1·45	0·07	..	..	0·90	1·75	2·50
10·85	9·20	1·45	1·60	0·40	0·35	0·68	..	0·09	0·09	0·12	1·60	2·55	3·60	3·60
7·05	11·05	12·15	3·45	14·45	5·70	5·80	11·25	5·85	3·70	1·70	2·50	0·30	2·80	11·75
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0·51	0·06	0·06	0·02	0·45	0·93	0·94	0·05	2·11	0·35	1·00	1·19	2·45	0·04	4·40
0·09	0·27	..	0·37	2·13	5·18	4·70	0·74	2·77	..	..	..	16·23	..	..
0·23	0·14	..	0·27	2·92	5·04	10·93	5·84	1·84	1·88	1·70	1·96	1·92	2·04	3·10
..	1·35	1·27	1·36	1·06	3·32	0·04	0·32	1·49	4·40	2·22	1·55	1·92	1·40	0·33
8·39	10·81	2·51	2·34	0·51	0·96	0·11	0·16	0·19	1·48	0·14	0·05	0·01	1·09	0·98
2·49	7·08	3·52	1·41	1·83	10·95	1·34	..	0·46	3·13	3·39	8·64	10·30	1·11	0·52
0·48	1·29	0·13	0·91	0·21	1·07	0·48	0·35	0·04	..	..	..	0·98	5·19	5·67
0·50	0·16	1·32	0·46	..	0·43	5·62	6·07	1·33	1·08	..	2·56	5·54	4·74	9·53
0·08	..	2·91	1·55	0·72	1·03	4·20	2·24	4·92	4·66	5·73	4·74	6·33	5·45	6·95
0·12	..	1·31	1·35	0·66	0·53	0·46	0·26	2·78	9·33	27·13	15·74	11·88	6·02	4·00

18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total.
In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
..	0·79	..	2·49	1·79	..	2·04	1·99	..	..	1·00	2·13	0·49	1·19	52·53
7·30	7·40	5·50	4·20	4·50	0·20	0·80	..	..	0·60	1·80	0·90	0·40	..	59·20?
0·90	0·20	2·20	1·75	0·85	6·40	1·70	2·40	3·10	4·40	0·30	0·50	0·20	1·45	56·10
8·36	2·80	..	6·72	0·88	2·30	5·72	9·75	0·32	1·91	2·12	3·45	..	1·59	97·22
..	..	0·10	..	1·80	4·40	2·45	1·05	5·05	..	2·30	..	0·35	0·27	123·97
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3·14	1·50	7·46	6·82	6·25	4·29	1·47	1·92	1·04	1·48	0·29	0·05	0·03	0·01	54·69
2·77	3·53	1·08	1·07	0·13	..	..	1·98	1·64	0·06	0·03	0·07	0·76	0·60	53·54
5·11	0·48	0·21	0·61	0·04	0·04	0·41	0·05	0·38	0·05	1·00	..	0·58	0·77	52·71
4·23	1·83	0·06	..	1·47	2·21	3·92	2·87	0·69	2·81	1·82	0·15	0·02	0·04	45·36
0·20	0·48	0·83	0·66	2·44	3·25	17·69	12·86	2·69	1·70	..	0·06	0·81	..	83·80
0·02	0·72	0·29	1·31	0·59	1·40	0·10	..	0·48	..	..	..	0·67	0·06	65·02
0·99	8·18	2·50	..	..	3·28	..	..	..	..	0·07	..	..	..	39·30
3·90	2·05	0·04	0·41	..	0·82	8·93	9·70	24·60	15·44	6·82	..	..	0·34	118·61
13·60	6·63	0·97	0·08	0·03	2·60	0·02	1·84	0·02	1·81	..	1·42	0·50	0·09	90·16
4·07	1·60	0·25	0·43	2·11	1·32	2·67	6·75	2·83	1·81	6·12	0·60	3·96	0·13	119·92

* Not recorded.

ar.	Variation from Mean Annual Rainfall at Cherrapunji.	General Character of Monsoon Rains in Bengal.
	ins.	
77	−110·79	Considerably below the average in Northern and Central Bengal. It was exceptionally heavy in Burmah, Aracan and SE Bengal.
78	+58·75	About the average over the whole of Bengal, but more especially in Lower and Eastern Bengal, Assam and Cachar.
79	−6·07	Below the average in Western and Southern, and slightly above it in Northern Bengal, Aracan, Burmah and Assam.
80	+15·13	Generally slightly above the average, and well distributed throughout the season.

t will thus be seen that almost without exception the annual rainfall at

DAILY RAINFALL AT CHERRAPUNJI, SEPTEMBER 1865-1880.

Date.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
1865	0·24	..	..	6·59	3·69	3·82	3·14	..	..	..	..	..	..	..	..	..
1866	..	..	0·30	0·60	2·42	1·99	6·00	3·50	1·11	4·61	1·31	0·41	..	0·29	5·46	6·50
1867	..	..	2·85	..	5·55	0·50	2·50	1·25	0·20	..	..	0·70	..	..	0·75	..
1868	4·60	13·90	12·60	14·20	5·95	7·52	..	..	..	..	1·22	0·32	0·09	..	..	..
1869	..	..	..	..	4·10	4·58	13·95	4·07	..	0·20	..	1·30	..	..	3·10	4·20
1870	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1871	1·18	4·22	3·70	1·70	1·10	0·03	0·02	0·06	0·03	..	0·70	0·11	0·89	2·54	6·66	0·76
1872	0·82	2·78	17·37	12·28	10·47	7·91	3·25	0·70	0·09	..	..	..	..	..	..	0·27
1873	0·05	3·00	0·37	2·08	0·62	2·96	2·07	0·96	0·03	..	0·05	0·39	1·09	1·00	0·04	0·15
1874	0·06	0·07	0·09	0·72	0·04	0·78	0·49	3·05	3·26	3·32	5·04	5·11	5·10	4·54	3·65	2·08
1875	0·47	..	..	3·16	1·03	..	0·07	0·36	1·40	..	..	1·98	0·15	0·37	0·36	..
1876	0·01	1·61	2·02	0·27	..	0·07	0·04	0·38	0·11	0·08	0·15	0·46	..	..	..	0·02
1877	3·20	..	0·05	0·09	..	0·17	1·00	3·02	11·74	15·64	17·09	11·72	4·05	0·57	0·20	..
1878	2·14	6·88	2·54	..	0·23	0·22	1·12	0·90	1·10	8·13	12·05	5·47	4·53	1·00	..	0·21
1879	0·14	0·13	0·07	3·57	2·00	3·46	17·10	5·84	7·75	1·06	0·39	0·08	..	..	..	..
1880	0·18	1·60	3·14	0·97	1·02	0·24	0·26	..	..	..	..	..	..	0·79	..	0·05

Date.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total.
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
1865	..	0·67	..	..	0·23	0·22	..	..	2·14	..	0·21	..	..	..	20·95
1866	0·49	0·39	0·39	0·29	1·17	..*	..*	0·39	0·59	1·29	..	..	..	..	39·50?
1867	2·70	1·20	0·20	4·45	1·40	..	1·50	..	..	..	..	..	0·10	..	25·85
1868	1·00	1·90	..	1·50	10·11	0·11	11·93	3·20	..	..	4·78	3·84	0·16	..	98·93
1869	0·35	..	..	0·20	..	1·40	2·40	4·40	2·20	6·35	0·50	9·00	17·60	2·80	82·70
1870	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1871	2·25	0·32	0·04	0·01	0·11	0·61	2·93	1·30	0·24	0·03	0·01	..	0·24	1·85	33·64
1872	0·01	..	0·26	2·70	20·58	8·26	2·58	3·25	3·36	0·09	..	0·19	1·07	3·20	101·49
1873	0·88	0·14	0·52	0·53	1·02	0·09	0·03	0·04	0·63	0·25	0·39	1·78	0·57	..	21·73
1874	0·07	3·32	1·73	0·28	0·10	..	0·66	..	1·87	1·92	0·08	..	0·34	0·19	47·96
1875	..	..	0·26	..	0·28	0·11	0·03	..	..	1·00	0·51	0·24	2·57	0·05	14·40
1876	..	0·10	..	0·73	2·27	3·28	3·20	3·52	0·52	0·10	0·21	0·24	..	0·04	19·43
1877	..	..	0·16	0·93	1·02	0·10	..	..	1·96	0·59	1·62	6·02	32·24	6·87	120·05
1878	..	0·60	..	..	..	9·86	12·42	5·90	0·30	..	..	0·78	0·30	..	76·68
1879	..	..	..	..	..	..	0·35	1·20	0·66	0·79	0·25	..	0·13	0·27	45·24
1880	0·73	..	..	..	0·21	0·14	..	..	..	0·17	2·11	3·60	2·73	6·88	24·88

* Not recorded.

Cherrapunji is similar in character to that of the rainfall of the neighbouring plain districts.

Rainfalls exceeding 20 ins. during twenty-four hours have been recorded on fourteen occasions during the fifteen years over which the daily observations of rainfall extend.

These rainfalls with their dates are given in the following table :—

Date.	Rainfall in 24 hours.	Date.	Rainfall in 24 hours.
	ins.		ins.
June 25th, 1866.	20·25	June 14th, 1876.	40·80
„ 27th, 1867.	20·25	„ 15th, „	22·84
„ 28th, „	23·00	July 6th, 1874.	20·50
„ 18th, 1872.	24·00	August 26th, 1878.	24·60
„ 13th, 1875.	21·00	„ 12th, 1880.	27·13
„ 14th, „	21·14	September 21st, 1872.	20·58
„ 12th, 1876.	30·45	„ 29th, 1877.	32·24

MONTHLY AND ANNUAL AVERAGE RAINFALL AT CHERRAPUNJI.

r.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
2	—	—	—	—	—	—	73·72	52·38	55·30	?	?	?	..
1	0·75	3·05	1·30	31·35	114·90	148·53	96·28	88·54	66·46	40·30	?	?	591·46+
2	..	1·45	9·90	28·60	49·75	83·25	168·52	58·45	49·71	1·50	1·20	..	452·33
3	0·60	..	3·45	26·50	44·20	130·85	66·80	108·45	135·15	5·25	3·25	..	524·50
4	..	3·59	6·52	33·24	10·95	146·57	141·88	140·76	23·92	31·78	13·37	..	552·58
0	..	1·80	1·60	48·12	70·80	113·37	161·91	149·27	94·91	58·15	?	?	699·93+
1	1·75	..	?	93·26	141·81	136·49	366·14	65·92	80·41	7·54	11·80	..	905·12+
3	?	..	..	21·80	37·03	105·09	116·23	91·58	70·75	1·20	..	..	443·68+
4	0·30	18·60	4·55	22·35	36·09	119·28	138·25	95·90	32·85	9·35	0·60	..	488·12
5	..	1·37	2·40	11·53	59·00	139·00	208·40	58·80	20·50	3·10	..	..	504·10
6	0·85	2·88	8·18	?	20·78	94·67	122·26	58·00	38·90	23·34	?	?	369·86+
7	0·60	1·50	7·50	14·60	?	102·46	130·76	56·92	25·85	10·41	?	?	350·60+
8	?	?	?	?	?	134·95	170·28	82·74	85·74	1·36	?	?	475·07+
9	0·52	3·64	3·89	36·71	76·73	118·90	157·35	80·05	60·47	17·66	3·10	..	559·02
1	?	0·91	5·03	20·36	33·33	78·08	73·71	54·69	33·64	21·20	0·50	..	321·45+
2	0·51	0·35	11·59	28·95	34·61	103·65	129·05	53·54	101·49	13·72	0·37	..	477·83
3	0·21	4·14	11·45	17·94	13·36	88·82	71·04	52·71	21·73	0·97	..	0·63	283·00
4	1·07	4·66	10·97	28·33	96·43	64·27	115·10	45·36	47·96	8·03	0·37	..	422·55
5	2·77	0·79	6·94	54·35	22·78	134·16	88·09	83·80	14·40	0·50	..	..	408·58
6	..	1·63	17·57	31·91	53·86	184·80	79·37	65·02	19·43	15·76	..	..	469·35
7	1·16	1·14	11·10	11·76	35·19	45·59	111·07	39·30	120·05	4·87	0·10	1·07	382·40
8	2·05	3·78	10·07	20·24	19·03	136·01	151·77	118·61	76·68	8·33	5·37	..	551·94
9	..	0·78	0·38	10·86	84·69	134·80	106·89	90·16	45·24	11·57	..	1·75	487·12
0	2·03	4·55	50·30	56·08	24·68	121·73	95·27	119·92	24·82	8·12	0·14	0·68	508·32
1 4 s	0·76	2·76	8·79	30·90	51·43	115·88	130·84	79·62	56·10	13·65	2·23	0·23	493·19

The heaviest rainfall in one day that has been recorded at Cherrapunji is 40·8 ins. (on June 14th, 1876), an average of 1·7 in. per hour. The table shows that rainfalls exceeding 20 ins. in the twenty-four hours are rarely observed except in the month of June, and that even these are unusual occurrences. The greatest number of days on which rainfalls exceeding 20 ins. have occurred in one year is *three*.

The following figures show the number of days in which rainfalls exceeding 10 ins. in the twenty-four hours have been recorded for the various months of the year during the period 1865-80:—

March	...	2	June	...	87
April	...	8	July	...	48
May	...	8	August	...	19
		September ...	19		
	October to February	...	0		

It is also clear that rainfalls exceeding 10 ins. are almost exclusively confined to the four months of June to September, when the South-west Monsoon prevails in full strength over Bengal.

The preceding statements have illustrated the fact that excessive steady

and continuous rainfalls at Cherrapunji are not of frequent occurrence, and that they are exceptional in character.

One very marked feature in the rainfall of Bengal during the South-west Monsoon is its intermittent character. During this period the action between the sea area to the south of India and the land area of India is not uniform and continuous, but peculiarly and dynamically oscillating. During one portion of the oscillating period, the barometer falls, the sea winds increase in strength and bring up general rain over the whole of Bengal. This period, during which rainfall is local in distribution and limited in amount, lasts from two or three days to a week or ten days. With the commencement of general rainfall, the barometer, almost immediately in the majority of cases, begins to rise, and the winds after a brief interval gradually diminish in strength. This period of general rainfall, accompanied by increasing pressure and diminishing wind intensity, varies in length from two to seven or eight days, but usually averages four or five days. The rainfall of Cherrapunji shows the existence of these periods of heavy rainfall, separated by intervals of light rain or of no rainfall, very clearly.

Amongst some of the heaviest of these periodic rainfalls, I may call attention to the following. The most prolonged interval of heavy rainfall contained in the records dates from July 21st to 29th, 1865. The rainfall during this interval was as follows :—

July 21st	... ...	12·16 ins.
„ 22nd	... ...	16·47 „
„ 23rd	... ...	18·40 „
„ 24th	... ...	16·50 „
„ 25th	... ...	15·15 „
„ 26th	... ...	10·18 „
„ 27th	... ...	10·99 „
„ 28th	... ...	15·75 „
„ 29th	... ...	17·84 „

giving a total of 128·39 ins., or an average daily rainfall of 14·26 ins. during this period. Amongst the most remarkable of the examples of the ordinary four or five day periods are the following :—

The first dates from August 24th to 28th, 1878, the rainfall being as follows :—

August 24th	... ...	8·93 ins.
„ 25th	... ...	9·70 „
„ 26th	... ...	24·60 „
„ 27th	... ...	15·44 „
„ 28th	... ...	6·82 „

giving a total of 65·49 ins., or 13 ins. per day.

The second dates from August 11th to 16th, 1880. The rainfall during this period was :—

August 11th	... ...	9·33 ins.
„ 12th	... ...	27·13 „
„ 13th	... ...	15·74 „
„ 14th	... ...	11·33 „
„ 15th	... ...	6·02 „

giving a total of 70·10 ins., or a daily average of 14·02 ins.

The third dates from July 3rd to 8th, 1874. The rainfall during this period was:—

July 3rd	... ...	8·97 ins.
„ 4th	... ...	6·38 „
„ 5th	... ...	18·45 „
„ 6th	... ...	20·50 „
„ 7th	... ...	11·55 „
„ 8th	... ...	11·32 „
		77·17 „

giving a daily average of 12·86 ins.

The most remarkable five day period is that of June 12th to 16th, 1876. The following gives the rainfall during this period:—

June 12th	... ...	30·45 ins.
„ 13th	... ...	7·75 „
„ 14th	... ...	40·80 „
„ 15th	... ...	22·84 „
„ 16th	... ...	12·30 „

giving a total of 114·14 ins. in five days, or an average daily rainfall of 22·83 ins. during this period, or very nearly one inch per hour for five days in succession. The rainfall at Cherrapunji may hence be characterised as not only excessive so far as the total amount is concerned, but as marked by the occasional occurrence of heavy continuous rainfall extending over periods lasting from three to eight days.

The rainfall during one of these periods, when it is excessive in amount, averages from half an inch to an inch per hour.

The observations taken under Capt. (now Col.) Godwin Austen's superintendence generally give the rainfall of each day. But during a few months the rainfall during the day and the night were separately registered, apparently with the intention of giving precision to the frequent remarks in the returns as to the frequent occurrence of the heavy rainfalls at night. The general remarks are in character similar to the following:—"The heaviest rainfall in 1869 up to date (end of September) occurred on the night of the 28th and 29th of September, commencing about 8 p.m.; 17·5 ins. of rain fell up to 9 a.m. of the 29th, or at the rate of 1·35 in. per hour. Severe thunderstorms at 1 a.m. and again between 3 and 4 a.m. with vivid continuous lightning." They indicate generally the marked tendency to the occurrence of heavy rainfall at night. Separate rainfall observations for

night and day were taken during the months of May and June 1867, August 1868, September 1868, and September 1869.

From May 19th to the 31st, 1867, 6·45 ins. of rain fell between the hours of 9 a.m. and 3 p.m., and 33·52 ins. during the eighteen hours' period 3 p.m. to 9 a.m. The ratios of the rainfalls are 1 : 5·2, whilst that of the intervals is 1 : 3.

Again, in the month of June, 1867, 17·1 ins. fell during the six hours' period 9 a.m. to 3 p.m., and 85·26 ins. during the eighteen hours' period 3 p.m. to 9 a.m. The ratio of the rainfalls is almost exactly 1 : 5.

The return for August, 1868, shows that 13·66 ins. fell during the seven hours' daily period from 9 a.m. to 4 p.m., and that 69·08 ins. fell during the remaining seventeen hours' period. The ratio of the amounts is very nearly as 1 : 5, while that of the periods is 2 : 5 very nearly, indicating that the rate of rainfall by night was, roughly speaking, double that of the day rate.

Again, in September 1868, 13·19 ins. fell during the seven hours' period from 9.30 a.m. to 4.30 p.m., whilst 72·55 ins. fell in the seventeen hours' period from 4.30 p.m. to 9.30 a.m. The ratio of these amounts is 1 : 5·5, slightly greater than the ratio in the preceding month.

In September, 1869, 12·51 ins. were registered for the seven hours' period 9.30 a.m. to 4.30 p.m., and 70·19 ins. during the seventeen hours' period, giving a ratio of 1 : 5·6, very nearly identical with the corresponding ratio for September 1868.

Hence, although the evidence (of which I have given the whole) is limited, it is concordant throughout, and points conclusively to the fact that the night rate of rainfall is much greater than the day, and that, roughly speaking, at least twice as much rain falls by night as by day at Cherrapunji.

The only other point of interest on which the returns throw light is the important subject of variation of pressure antecedent to, and coincident with, heavy rainfall. As far as the evidence goes, it shows almost conclusively that the variations of pressure are remarkably small in amount, even during the period of heaviest rainfall, and also that the effect of very heavy rainfall is on the whole rather to increase pressure at Cherrapunji than to diminish it.

During the greater part of the time when observations were taken at Cherrapunji under Col. Godwin Austen's superintendence, the observations were only those of temperature, wind-direction, cloud, and rainfall. During a few months readings of an aneroid barometer were taken, and for a portion of two more, September and October, 1867, readings were taken of a mercurial barometer. The results of the former observations, viz. the readings of the aneroid barometer, are given in the following table ;—

Month.	Aneroid Barometer. Maximum Reading.	Aneroid Barometer. Minimum Reading.	Aneroid Barometer. Difference.	Rainfall. Total.	Rainfall. Heaviest in 24 hours.
	Ins.	Ins.	In.	Ins.	Ins.
June 1865	25·78	25·20	·58	139·0	13·53
July 1865	26·00	25·00	1·00	208·4	17·84
August 1865	25·84	25·40	·44	58·8	8·80
September 1865	25·84	25·56	·28	20·5	6·59
June 1866	25·81	25·48	·33	94·67	20·25
July 1866	25·86	25·67	·19	122·26	10·70
August 1866	25·92	25·70	·22	58·00	7·40
September 1866	25·91	25·72	·19	38·90	6·50
August 1868	25·84	25·46	·38	82·74	10·25
September 1868, 1st to 24th	25·82	25·53	·29	85·74	12·40

When it is remembered that these limits or monthly variations necessarily include the amount of the daily range (nearly as large as in the plains and probably averaging 0·1 in.), the very slight changes of pressure which are associated with the heavy rainfall at Cherrapunji become even more striking and marked.

The two accompanying tables (p. 57) (of observations taken at Cherrapunji in September and October, 1879) give the only barometrical observations recorded at Cherrapunji in the possession of the Bengal Meteorological Department. The tables give the complete observations as taken by the Survey Party under Capt. Godwin Austen. They confirm generally the preceding remarks, and more especially the inference derived from an examination of the readings of the aneroid barometer, that the changes of pressure are extremely small at Cherrapunji. This may be stated in other words,—that the atmospheric changes of pressure due on the one hand to aqueous vapour condensation and rainfall precipitation, and, on the other hand, to variations in the velocities of air motion, &c., are so nearly balanced as to give rise to hardly any appreciable effect on the pressure variation. The actual variations of pressure which occur are, therefore, almost entirely due to its connection with the neighbouring plain districts of Northern India. The diurnal oscillation of the barometer is as clearly marked, and is almost as large as it is in the plains, whilst the other ordinary oscillations are similar in character to the oscillations of long and short period due to or accompanying the changes of temperature and of other meteorological conditions of Northern India.

The tables it is hoped explain themselves sufficiently, and are merely added as a brief illustration of the general character of the weather during, and at the end of, the rains at Cherrapunji.

DISCUSSION.

Prof. ARCHIBALD said that he passed through Cherrapunji in June 1876, on his way from Shillong to Dacca, and as it so happened only two days before the heaviest fall of rain ever recorded there in 24 hours, viz., 40 ins. He remem-

Meteorological Observations at Cherrapunji, September, 1868.

Date.	9.30 a.m. Barometer reduced to 32°.	9.30 a.m. Wind. Direction.	9.30 a.m. Wind. Strength.	9.30 a.m. Rainfall.	4 p.m. Barometer reduced to 32°.	4 p.m. Wind. Direction.	4 p.m. Wind. Strength.	4 p.m. Rainfall.	Remarks.
	Ins.			Ins.	Ins.			Ins.	
1	25·82	S	Light	4·30	25·72	SW	Fresh	0·30	T to S at 1 a.m., wind high 4 a.m. ●². Fine day, but cloudy. T 2.30 a.m.
2	·75	S	Strong	10·80	·68	S	Light	3·10	●² and stormy wind, dark morning. High wind till 3 p.m., then lulled
3	·71	SW	High	8·60	·62	WSW	Fresh	4·00	Fine to 1 p.m. ● then came on, windy and rainy morn. ●² at 2 p.m. clearing
4	·67	SW	Calm	12·40	·61	NW	Light	1·80	●² cleared up, clouds high
5	·68	SW	Calm	4·40	·61	SW	Light	1·55	≡ and ● all day
6	·73	S	Calm	7·52	·63	..	Calm	..	Very misty, ● all night and morn. Very fine after 12, sunny
7	·75	NE	Light	..	·69	N	Calm	..	Fine day, few low clouds. Lovely day
8	·77	..	Calm	...	·66	NE	Calm	..	Very fine morn. Very fine and clear
9	·75	ENE	Calm	..	·68	..	Calm	..	A most lovely morn. Lovely day, distant T
10	·71	E	Calm	..	·60	NE	Calm	..	Lovely morn in E distant. Very fine all day. T at 1.30
11	·70	E	..	1·10	·58	..	Calm	0·12	Cloudy but fine
12	·65	NE	Calm	0·23	·57	ESE	Calm	0·09	Shower at 8 a.m. Fine day with showers
13	·66	E	Calm	0·09	·642	NE	Calm	..	Fine, rather cloudy. Fine all day.
14	·712	N	Calm	..	·597	NE	Calm	..	Lovely sunny morn. Lovely sunny day
15	·650	NW	Calm	..	·600	NE	Calm	..	Hot fine day
16	·684	E	Light	..	·581	E	Calm	..	Lovely day
17	·694	ENE	Light	..	·610	NNE	Fresh	1·00	Fine morn, distant T 4 a.m., began to ● 10 a.m
18	·610	NNE	Calm	1·90	·638	E	..	..	≡ morn, fine at 9 a.m.
19	·732	SE	..	..	·620	S	..	..	Fine morn. Lovely day
20	·720	S	..	1·50	·619	SE	Calm	..	K² at 2 a.m. Fine bright day
21	·745	S	Calm	10·00	·654	SE	Light	0·11	T at 10 p.m., when ● set in. ● in morn up to 9 a.m.
22	·792	SE	Light	0·11	·703	S	Calm	..	Fine all night. Light drizzle at 5 p.m., cloudy and chilly. ● began 6 p.m.
23	·765	S	Fresh	11·55	·687	S	Light	0·38	●² at 7 a.m. to 8 a.m. Misty day with showers
24	·801	S	Calm	3·20	·726	..	Calm	..	● at night on and off. Cloudy day
25	·717	E	..	..	·725	..	Calm	..	Cloudy. Fine evening
26	·726	N	..	..	·705	S	..	..	Very cloudy
27	·731	SW	..	4·15	·769	S	..	0·63	Drizzle and ● at night. Fine
28	·839	S	..	3·73	·757	E	..	0·11	● at night. ● up to 2 p.m.
29	·846	E	..	0·16	25·736	S	..	..	Fine light drizzle in morn. Clear fine day
30	25·789	N	..	..	..	SSW	..	..	Fine morn. Bright evening

METEOROLOGICAL OBSERVATIONS AT CHERRAPUNJI, OCTOBER 1858.

Date.	9.30 a.m.				4 p.m.				Remarks.
	Barometer reduced to 32°.	Wind.		Rainfall.	Barometer reduced to 32°.	Wind.		Rainfall.	
		Direction.	Strength.			Direction.	Strength.		
	Ins.			Ins.	Ins.			Ins.	
1	25·785	E	..	..	25·650	S	..	..	Fine
2	·779	S	..	..	·659	S	..	..	Cloudy
3	·828	E	..	0·15	·665	S	..	..	Cloudy, but fine. Rather misty, but fine
4	·824	NE	..	..	·714	S	..	..	Cloudy, but fine
5	·809	S	Light	..	·704	S	Calm	..	Fine morn. Cloudy to S. A few light showers
6	·789	S	Calm	0·62	·681	S	Calm	..	T at night, drizzle. Little ● up to noon, fine after
7	·760	NE	Calm	0·12	·656	SW	Calm	...	Fine light moon. ≡. Heavy clouds
8	·764	N	..	..	·687	NE	Still	..	Bright clear morn. Lovely day
9	·788	NE	Light	..	·698	SW	Still	..	Lovely day
10	·880	NE	Light	..	·810	NE	Calm	..	Fine, with clouds
11	·896	NE	Light	..	·858	NE	Light	..	Fine and clouds high. A shower in middle of day
12	·913	S	Calm	0·12	·805	S	Still	..	● commencing. Fine evening
13	·902	S	Light	0·35	·772	SW	Light	..	Fine sky, with clouds. Lovely evening
14	·905	NE	..	..	..	SW	Light	..	Lovely day
15	·863	NE	Calm	..	·897	W	Light	.	Fine
16	·919	E	Very Light	..	·842	SE	Calm	..	Lovely day
17	·949	NE	Light	..	·851	SSE	Light	..	Lovely day
18	·960	ENE	Light	..	·855	NE	..	..	Lovely day
19	·963	..	..	..	·822	S	Light	..	Lovely weather. Fine bright day
20	..	..	..	..	·793	SW	Light	..	Lovely day. Fine bright day
21	·870	E	Light	..	·785	S	Light	..	Lovely day
22	·870	E	Light	..	·772	SE	Calm	..	Lovely day
23	·863	NE	Calm	..	·798	SSW	Light	..	Fine day
24	·861	SE	..	..	·752	S	..	..	Fine
25	·851	E	..	..	·784	SE	..	..	
26	·882	E	..	..	·803	S	Light	..	Lovely day, little cloudy
27	·910	E	..	...	·800	SW	..	..	Very fine
28	·922	NE	..	..	·801	S	..	..	Lovely day
29	·921	SW	..	..	·783	SW	..	..	Fine day
30	·925	SW	..	..	·800	SW	..	..	Fine, cloudy in evening
31	25·945	SW	..	..	25·858	..	..	..	Fine, rather cloudy

bered making a note of it from an Official Gazette he saw shortly afterwards, and was glad to find it confirmed by Prof. Eliot in the present paper. On the day he left (Monday, June 12) it rained 30 ins., the next day it rained 12 ins., and on Wednesday, June 14th, 40 ins., thus making a total fall in three days of 82 ins. While this unprecedented fall of 40 ins. was taking place in Cherrapunji, he experienced on the plains at about 50 miles from the base of the hills a succession of tremendous thunderstorms and heavy rain, lasting nearly continuously for about 48 hours. He then drew attention to some of the local physiographical peculiarities of Cherrapunji, alluded to by Prof. Eliot, and also by Mr. Blanford in a previous paper, especially to the fact of the station lying on a plateau between the general steep escarpment of the Khasia Hills facing the Bay of Bengal, and a deep, narrow, and precipitous gorge which curved round and finally debouched south-eastwards on to the plains. Up this gorge the vapour laden currents pressed, and finally meeting with a *cul-de-sac* near the station, were forced vertically upwards, so as to add the effects of their rapid aqueous condensation to the precipitation due to the currents which, on the other side of the station, were forced directly up the front escarpment. Mr. Blanford had ascribed the peculiarly heavy rainfall of the place to its singular position in these respects, but when at Shillong in 1876, he heard that a rain-gauge which had been started a few months previously at Jowai, another place on the Khasia Hills, not possessing, like Cherrapunji, a gorge at its back, showed for that period a rainfall quite as heavy, and for one month a slightly greater quantity. He further remarked that the height of Cherrapunji (4000 ft.) agreed with that which had been shown by Prof. Hill in a paper published in the Austrian *Zeitschrift für Meteorologie* for 1879, to be the height of the zone of generally maximum rainfall in the Himalayan region. It was also noticeable as being possibly a consequence of the heavy rainfall to which the place was subjected during the summer Monsoon, that it literally teemed with leeches, which dropped from the trees on passers by. At the same time the rain was drained off almost as rapidly as it fell by rivulets and cataracts down the gorges, and that though subject, as all Indian hill-stations were, to what was called hill-diarrhœa, and to occasional epidemics of cholera brought from the plains, it was reported to be healthier even than Shillong, which lay higher, and where the annual rainfall was only 70 ins.

Mr. Scott said that of late years Dr. Hann had, in various papers published in the *Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie*, pointed out from the observations at Batavia and elsewhere that the barometer rose during and after heavy rain, so that the mere condensation of moisture could not be the chief cause of the oscillations of the barometer, for, if it were, a downpour of rain would cause the mercury to fall.

Dr. Williams said that he had made a number of comparisons of the healthiness of hill stations in various parts of the world, and found that the hill stations in India were not so healthy as in other countries, *e.g.* the Andes, or the Alps. He also stated that diarrhœa, bowel complaints, and consumption were very prevalent at the Indian hill stations, but considered the cause of them to lie in the excessive moisture from rainfall mentioned by the author of the paper, and confirmed by Prof. Archibald.

Mr. Laughton had long held that the fact of the excessive rain at Cherrapunji being unattended by any whirling wind is a strong argument against the condensation theory of the origin of cyclones. This opinion was now confirmed by the statement of Prof. Eliot that during this extraordinary rain the barometer rises. Clearly if condensation does not produce an area of low pressure, there can be no aspiration towards it, and the theory of cyclones, based on such aspiration, falls to pieces. It would be interesting to know how it is that the barometer rises during condensation and precipitation, when, according to the received idea, it ought to fall. Possibly it may be that the heat set free by the condensation, acting within a limited space, exercises an expansive tendency on the air and thus increases the elastic force. But whatever may be the reason, the fact, as stated, was one of very great theoretical importance.

Mr. Baldwin Latham observed that rain falling so continuously would, under the circumstances, tend to produce an induced current, which would draw down the upper air and so lead to an accumulation of air in the lower atmosphere, which would probably prevent the barometer from falling.

Dr. TRIPE said that Sir J. Fayrer, who had spent the greater part of his life in India, stated in his paper on the climate of India that he had registered 610 ins. at Cherrapunji, and 300 ins. at Mahabuleshwur in the Western Ghauts, which is the next wettest place in India.

Capt. TOYNBEE said he agreed with Mr. Strachan in thinking that the circumstances of Cherrapunji were exceptional, and could not be taken as evidence against the theory which supposes that the condensation of moisture from the air plays an active part in the formation of cyclones; for in cyclones a central area of low barometric pressure is formed, towards which air is drawn from all sides, whereas at Cherrapunji there is] a mountain-precipice presenting an obstacle to a strong current of air already in existence, hence it can hardly be supposed that there will be a deficiency in the amount of air at that place. We have, however, still much to learn respecting the formation of cyclones.

The PRESIDENT (Mr. Symons) said he was surprised that Prof. Eliot had made no reference whatever to Oldham's Work, which contained, printed *in extenso*, a series of observations taken at Cherrapunji, all instruments except, unfortunately, the rain gauge, being read four times a day. From the 'term day observations' it appeared that the rainfall at night was in excess of that in the day. Prof. Eliot had done a great service by collecting and tabulating the various records, but he regretted that no one had set up two or three gauges on various parts of the hill instead of one only, for small as was the area of the station, the fall in different parts would very likely be found to differ by 100 ins. or more, according to proximity to the precipitous face of the cliffs.

ON THE METEOROLOGY OF CANNES, DEPARTMENT DES ALPES MARITIMES, FRANCE. By WILLIAM MARCET, M.D., F.R.S., F.M.S.

[Read December 21st, 1881.]

I HAD the honour of reading a Paper to the Meteorological Society in June 1877, entitled "Contribution to the Meteorology of Cannes."* My present object is to complete this communication by giving the records of my observations during the six seasons I have spent at that favourite health resort, extending to the six winter months 1879-80 inclusive.

My barometer and thermometers were made by Casella, the latter being either supplied with the Kew corrections or tested for accuracy by myself in melting ice. The maximum and dry and wet bulb thermometers were mounted in a louvred screen placed on the north side of the house, and thus sheltered from the sun. The minimum thermometer was under a louvred screen standing on a lawn in front of the house, about four feet above ground. During the first five seasons I resided close to the sea, on a spot fully exposed to the winds, and while there, the screen on the north side of the house was placed on a first-floor balcony. In the autumn of 1879 I removed to another house situated at an elevation of 80 feet above the sea, and rather less than a mile from the seaside; the screen on the north side of the house then stood on the ground about four feet high. The site of this last villa was somewhat colder than that of the first, as will be clearly seen from simultaneous observations made in 1878-79 (before my removal) at both stations. A friend, living at the Alsace-Lorraine Hotel, near the "Boulevard

* Quarterly Journal, Vol. III. p. 478.

du Cannet," kindly undertook to read my instruments at the upper station, which happened to be close to the spot where the villa I last inhabited was subsequently built.

OBSERVATIONS OF TEMPERATURE taken at the immediate Sea-side; and near the "Boulevard du Cannet," 80 feet above the Sea.

Season 1878-79.	December.		January.		February.		March.		Means.	
	Sea-side.	High Station.	Sea-side.	High Station.	Sea-side.	High Station.	Sea-side.	High Station.	Sea-side.	High Station.
	°	°	°	°	°	°	°	°	°	°
9 a.m.	42·5	43·1	47·1	45·5	47·6	46·4	52·2	52·6	47·3	46·9
Maximum	49·0	47·8	53·7	52·6	56·2	53·2	58·4	58·8	54·3	53·1
Minimum ..	38·8	35·6	43·5	39·3	43·6	40·3	46·0	43·4	43·0	39·6

It will be seen from these observations that while the mean temperature at 9 a.m. was nearly the same at both stations, the mean maximum was 1°·2 lower at the higher of the two; while the mean minimum temperature fell at that station by 3°·4 below the mean minimum at the sea-side. The mean minimum temperature stood higher at the sea-side station for every month, showing clearly the influence of the heat stored up in the sea during the summer towards warming the atmosphere of the immediate sea-side in winter, especially at night. The high station was situated on the top of a hill, and not on a slope facing the south, otherwise the result of these observations might have been somewhat different.

The Weather.—The state of the weather was carefully noted three times a day during the six seasons, and has been disposed under the form of the following table, in which I have introduced my records of the weather at Nice during the seasons 1872-73 and 1873-74 :—

THE WEATHER AT CANNES.

Months.	Nice. 1872-73.			Nice. 1873-74.			1874-75.			1875-76.			1876-77.			1877-78.			1878-79.			1879-80.			Means of the Eight Seasons.		
	Fine.	Overcast.	Rainy.	Fine.	Overcast.	Rainy.	Fine.	Overcast.	Rainy.	Fine.	Overcast.	Rainy.	Fine.	Overcast.	Rainy.	Fine.	Overcast.	Rainy.	Fine.	Overcast.	Rainy.	Fine.	Overcast.	Rainy.	Fine.	Overcast.	Rainy.
November	19	3	8	20	1	9	20	2	8	19	2	9	17	4	9	19	1	10	15	1	14	18	3	9	17·5	2·1	9·5
December	12	5	14	26	4	1	18	0	13	20	2	9	14	5	12	21	5	5	12	6	13	27	1	3	18·8	3·5	8·8
January..	20	6	5	26	2	3	23	5	3	14	3	14	20	5	6	27	0	4	17	2	12	21	7	3	21·0	3·8	6·3
February	19	5	4	18	4	6	15	4	9	24	2	3	25	2	1	26	0	2	12	4	12	20	4	5	20·0	3·1	5·3
March ..	20	1	10	26	1	4	21	3	7	19	2	10	16	5	10	24	2	5	22	0	9	22	7	2	21·3	2·6	7·1
April	21	0	9	21	1	8	20	1	9	15	0	15	17	3	10	15	2	3	22	2	16	16	3	11	18·4	1·5	10·1
Total ..	111	20	50	137	13	31	117	15	49	111	11	60	109	24	48	132	10	29	100	15	76	124	25	33	11·9	16·6	47·1

The mean of the eight seasons of 181 days would be—

Days fine.	Overcast without rain.	Rainy.
117	17	47

The several months in succession, beginning with those with the greatest mean number of fine days, will read as follows :—

	Mean number of fine days.
March	21·8
January	21·0
February	20·0
December	18·8
April	18·4
November	17·5

It is interesting to observe that the number of days *fine*, *overcast*, and *rainy*, as obtained from my first series of observations during six seasons, is exactly the same as that from the eight seasons (as may be seen by referring to my former communication), giving weight and confidence to the results of the present inquiry.

I have calculated the difference between the figures for the mean observations for each of the six months of the eight seasons and those recorded for each month, so as to obtain an insight into the difference between the *probable* and *actual* weather. This difference, calculated for the eight seasons, was as follows :—

MEAN DIFFERENCE BETWEEN PROBABLE AND ACTUAL WEATHER EXPRESSED IN DAYS. ±

	Fine.	Overcast.	Rainy.
November	1·6	0·9	1·25
December	4·8	1·9	4·2
January	3·25	1·9	3·4
February	3·9	1·15	3·5
March	2·25	1·8	2·6
April	2·6	1·0	3·1

This table shows that we can predict the weather more safely for November, March, and April, than for January, February, and December; or, in other words, that the weather is more uncertain in the latter than in the former three months.

March, January, and February exhibit the greatest number of fine days; indeed, those three months constitute much the best part of the season at Cannes.

Atmospheric Pressure.—The barometer readings, reduced to 32° and sea-level, from daily observations at the stated hours, were as follows :—The fall at 2 p.m. is very marked, and was usually accompanied in settled fine weather with a southerly breeze beginning between 10 and 11 a.m. and subsiding somewhat before sunset. There are many points of interest connected with the changes of atmospheric pressure at Cannes, to which I would advert were it not that it would add, I fear, too much to the length of the present communication.

ATMOSPHERIC PRESSURE.

Months.	1875-76. 9 a.m.	1875-76. Midnight.	1876-77. 9 a.m.	1876-77. 2 p.m.	1876-77. Midnight.	1877-78. 9 a.m.	1877-78. 2 p.m.	1877-78. Midnight.
	In.	In.	In.	In.	In.	In.	In.	In.
November	29·790	29·773	29·897	29·825	29·896	29·916	29·866	29·884
December	30·002	29·996	29·773	29·745	29·770	29·960	29·929	29·961
January	30·136	30·133	30·031	30·011	30·028	30·000	29·982	29·981
February	29·930	29·925	29·930	29·901	29·919	30·238	30·302	30·202
March	29·704	29·710	29·769	29·721	29·740	29·904	29·866	29·904
April	29·861	29·852	29·708	29·674	29·696	29·838	29·826	29·838
Means	29·904	29·898	29·851	29·813	29·841	29·976	29·945	29·968

Months.	1878-79. 9 a.m.	1878-79. 2 p.m.	1878-79. Midnight.	1879-80. 9 a.m.	1879-80. 2 p.m.	1879-80. Midnight.
	In.	In.	In.	In.	In.	In.
November	29·794	29·764	29·797	29·970	29·942	29·973
December	29·742	29·723	29·746	30·207	30·166	30·205
January	29·931	29·894	29·918	30·235	30·216	30·252
February	29·635	29·599	29·626	30·031	29·999	30·016
March	29·932	29·905	29·925	30·129	30·101	30·114
April	29·621	29·596	29·619	29·876	29·844	29·857
Means	29·776	29·747	29·772	30·075	30·045	30·070

The Atmospheric Temperature.—The mean temperature of the atmosphere at 9 a.m. is 50°·2; at 2 p.m 55°·0, or 55°·8 with the correction applied to the reading at the higher station; and at midnight 49°·1, or 49°·5 with the correction; the range being—between 9 a.m. and 2 p.m. 5°·1, and between 2 p.m. and midnight 5°·8.

TEMPERATURE.

Months.	9 a.m. 1874-75.	9 a.m. 1875-76.	9 a.m. 1876-77.	9 a.m. 1877-78.	9 a.m. 1878-79.	9 a.m. 1879-80.	2 p.m. 1876-77.	2 p.m. 1877-78.	2 p.m. 1878-79.	2 p.m. 1879-80.	Midnight. 1874-75.	Midnight. 1875-76.	Midnight. 1876-77.	Midnight. 1877-78.	Midnight. 1878-79.	Midnight. 1879-80.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
November	54·0	53·2	53·2	55·5	49·8	51·1	57·9	61·1	54·2	55·2	..	..	51·7	54·5	48·1	54·5
December	45·2	45·9	51·8	47·9	42·5	41·2	56·2	53·6	47·6	46·0	..	..	50·8	47·1	43·0	47·1
January	49·6	48·6	48·4	44·4	47·1	43·6	55·8	51·8	52·0	49·4	..	..	49·2	43·9	46·1	43·9
February	44·2	48·6	49·1	45·1	47·6	48·3	55·4	55·0	52·6	53·3	..	..	48·3	47·3	47·3	47·3
March ..	51·0	53·0	50·5	50·8	52·2	53·9	53·9	54·0	57·4	56·6	..	..	47·3	48·1	50·6	48·1
April	56·7	57·5	57·8	57·3	54·1	58·3	61·9	61·9	58·3	60·2	..	..	54·8	54·5	51·9	54·5
Means ..	50·1	57·1	51·8	50·2	48·9	49·4	56·8	56·2	53·7	53·5	48·4	48·9	50·3	49·2	47·8	49·2

MEAN TEMPERATURE.

Months.	9 a.m.	2 p.m.	Midnight.
	°	°	°
November	52·8	57·1	52·2
December	45·7	50·8	47·0
January	46·9	52·2	45·8
February	47·1	54·1	47·5
March	51·9	55·5	48·5
April	56·9	60·6	53·9
Means	50·2	55·0	49·1

Corrected for sea-side................55·3...... ..49·5

The next table shows the maximum and minimum temperature for every month of the winter during the six seasons.

Months.	Mean Maximum Temperature. 1874-75.	1875-76.	1876-77.	1877-78.	1878-79.	1879-80.	Mean.	Mean Minimum Temperature. 1874-75.	1875-76.	1876-77.	1877-78.	1878-79.	1879-80.	Mean.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°
November ..	61·2	60·0	59·0	62·2	56·1	54·3	58·8	47·5	46·4	47·9	51·0	44·0	42·4	46·5
December ..	53·4	52·3	56·7	55·1	49·0	48·7	52·5	40·3	39·2	47·5	43·0	38·8	31·7	40·1
January ..	56·7	54·2	56·4	53·1	53·7	50·7	54·1	46·2	42·8	45·2	39·8	43·5	34·6	42·0
February ..	51·8	56·6	56·8	56·3	56·2	55·2	55·5	39·2	42·8	44·0	42·6	43·6	40·5	42·1
March	57·6	59·0	55·1	57·4	58·4	58·0	57·6	44·6	44·6	43·6	44·0	46·0	43·7	44·4
April	61·5	61·3	62·6	63·7	60·6	62·6	62·0	48·8	49·6	50·6	50·3	47·6	47·7	49·1
Mean	57·0	57·2	57·8	58·0	55·7	54·9	56·7	44·4	44·2	46·4	45·1	43·9	40·1	44·0

Corrected for sea-side ....57·0 ....44·6

The mean monthly temperature reckoned from the maxima and minima is given in the following table, and it is remarkable that the mean of the six seasons should coincide so nearly with the mean temperature at 9 a.m. 50°·2.

I have appended to this table the mean temperature of the six winter months from all the observations taken at the Royal Observatory, Greenwich, from the year 1814 to the end of 1873 (60 years), by James Glaisher, F.R.S. (*Quarterly Journal*, Vol. III. p. 198), from which it will be observed that the mean excess of temperature at Cannes over that at Greenwich for those six months is 9°·1; or 9°·6 with seaside correction.

MEAN MONTHLY TEMPERATURE FROM MAXIMA AND MINIMA.

Months.	1874-75.	1875-76.	1876-77.	1877-78.	1878-79.	1879-80.	Means.	Mean Temperature at Greenwich, 1814-1873.	Mean Difference.
	°	°	°	°	°	°	°	°	°
November	54·3	53·2	53·4	56·6	50·0	48·3	52·6	43·0	9·3
December	46·8	45·8	52·1	49·0	43·9	40·2	46·3	39·9	6·4
January	51·4	48·5	50·8	46·4	48·6	42·6	48·0	37·1	10·9
February	45·5	49·7	50·4	49·4	49·9	47·8	48·8	39·0	9·8
March	51·1	51·8	49·3	50·7	52·2	50·8	51·0	41·5	9·5
April	55·1	55·4	56·6	57·0	54·1	55·1	55·5	46·6	8·9
Mean	50·7	50·7	52·2	51·5	49·8	47·5	50·4	41·2	9·1

Corrected for sea-side.................................50·8............9·6

Months.	Extreme Max. Temperature.						Mean of Highest Maxima.	Extreme Min. Temperature.						Mean of Lowest Minima.
	1874-75.	1875-76.	1876-77.	1877-78.	1878-79.	1879-80.		1874-75.	1875-76.	1876-77.	1877-78.	1878-79.	1879-80.	
	°	°	°	°	°	°	°	°	°	°	°	°	°	°
November ..	69·0	74·3	65·4	70·3	62·7	64·5	67·7	39·2	31·7	35·6	41·7	38·1	31·7	36·3
December ..	62·4	57·2	64·9	60·8	55·4	58·7	59·9	29·8	32·5	37·6	36·7	28·4	21·9	31·1
January ..	67·2	58·6	61·1	58·4	62·8	59·8	61·3	33·4	37·0	38·1	32·7	32·0	28·2	33·6
February ..	64·4	71·6	67·1	61·4	60·9	62·0	64·6	31·4	30·2	38·9	36·1	32·0	32·9	33·1
March	64·4	69·0	63·3	65·4	62·4	65·8	65·0	37·4	32·1	32·2	32·9	36·5	34·7	34·3
April	68·0	68·0	67·5	67·5	66·9	66·8	67·4	42·8	38·8	43·4	47·1	38·2	41·5	40·3
Means ..	65·9	66·4	64·9	64·0	61·8	62·9	..	35·7	33·6	37·1	37·9	34·2	31·8	..

The mean and extreme Monthly Range of Temperature are as follows:—

	Mean.	Extreme.
	MONTHLY RANGE OF TEMPERATURE.	
	°	°
November	12·3	31·4
December	12·4	28·8
January	12·1	27·7
February	13·4	31·5
March	13·2	30·7
April	12·9	27·1

Solar Radiation.—I regret that this portion of my report should only apply to the two seasons 1878-79 and 1879-80. The observations for each of these seasons when compared with one another agree within comparatively narrow limits. I have appended the mean monthly relative humidity at 2 p.m., which corresponds nearly with the time of the maximum solar radiation. The mean maximum solar temperature for the two seasons was 101°·5 for the first and 108°·2 for the second; if the clouds and atmospheric humidity are the only media absorbing the heat of the solar rays, the drier the atmosphere, the higher will be the readings of the black bulb *in vacuo* and *vice versâ*. We find it so for the general means, the atmospheric moisture being rather higher in 1878-79, with a mean of 6°·7 less for solar radiation than in the following season.

SOLAR RADIATION.

Months.	1878-79.			1879-80.			Mean Solar Radiation, 2 Seasons.
	Mean.	Highest.	Relative Humidity at 2 p.m.	Mean.	Highest.	Relative Humidity at 2 p.m.	
	°	°	0/0	°	°	0/0	°
November	96·9	122	68·1	102·5	124	69·3	99·7
December	86·8	105	71·6	96·5	109	62·2	91·6
January	90·7	119	69·3	101·6	115	65·7	96·1
February	101·0	121	69·8	111·0	121	70·0	106
March	115·0	129	72·1	114·4	126	60·1	114·7
April	118·5	136	71·0	123·0	138	69·8	120·7
Means	101·5	122	70·3	108·2	122·2	66·2	104·8

December exhibits the lowest mean daily maximum solar radiation, and December is the coldest month of the season. It is interesting to observe how closely the highest maxima in each month agree with those of the corresponding months of the other season, the mean difference being only $\pm 2^{\circ}\cdot 7$.

NOCTURNAL RADIATION. MEAN MINIMUM TEMPERATURE ON THE GRASS.

Months.	1876-77.	1877-78.	1878-79.	1879-80.	Means.
	°	°	°	°	°
November	40·7	43·2	34·0	35·8	38·4
December	40·7	34·0	29·0	22·0	31·4
January	38·2	30·6	33·9	26·0	32·2
February	35·0	33·3	34·1	32·8	33·8
March	35·8	35·1	34·1	36·7	35·4
April	42·0	43·0	39·3	43·4	41·9
Means	38·7	36·5	34·1	32·8	35·5

The following was the mean difference (for radiation) between the minima under screen and on grass:—

MEANS OF FOUR SEASONS.

	°		°
November	7·9	February	13·4
December	8·8	March	8·9
January	8·6	April	7·1

This shows a marked terrestrial radiation after sunset, with its maximum degree in February; so that invalids must be particularly careful during that month of avoiding exposure to the atmosphere at that period of the twenty-four hours.

The lowest temperature registered on the grass for each month of the six seasons was as follows :—

EXTREME MINIMUM TEMPERATURE ON THE GRASS.

Months.	1876-77.	1877-78.	1878-79.	1879-80.	Means.
	°	°	°	°	°
November	25·5	27·2	22·5	19·6	23·7
December	27·0	27·5	14·5	13·4	20·6
January	26·0	18·4	24·0	15·9	21·1
February	23·7	26·9	18·4	22·9	23·0
March	17·5	24·0	25·9	26·9	23·6
April	32·0	26·0	28·5	35·3	30·2
Means	25·3	25·0	22·3	22·3	23·7

I have attempted to determine the progressive degree of evening and night radiation in clear weather by reading at night a thermometer hanging in the open air about three feet above ground every quarter of an hour between sunset and 11 or 12 o'clock; the elevation of three feet for the

thermometer's position being selected as the height at which a person would be most likely to be affected by the atmospheric temperature. At the same time the indications of dry and wet bulb thermometers placed under a louvred screen were recorded. The results of these observations were communicated in the form of charts to the Meteorological Society in 1877. They show a rapid fall of temperature immediately after sunset if the sky is quite clear. Should the atmosphere be in the least cloudy, or even hazy, the fall is checked or delayed.

Between one and two hours after sunset in clear weather, or at a mean time of one hour and nineteen minutes after sunset (seven series of observations), there is either a temporary check to the accession of cold or a slight rise of temperature not lasting over a quarter of an hour, and then it again falls.

The extreme differences observed were as follows :—

Feb. 18th	10·4°	between the hours of	5.18 and 9 p.m.
„ 23rd	10·8	„ „	5·10 and 9.15 „
March 15th	5·8	„ „	5.50 and 9.15 „
April 5th	6·8	„ „	6.30 and 11 „
„ 7th	5·4	„ „	6.15 and 11 „
„ 21st	4·8	„ „	6.30 and 11 „

In order to ascertain the mean coldest temperature to which a person out-of-doors would be exposed, I suspended a minimum thermometer on a stand in the open air, the instrument being nearly three feet above ground, and radiating as freely as possible. The readings were made daily during five months of the season 1879-80, and turned out, as might have been expected, intermediate between those on the grass and under the screen. They are as follows—the minima under the screen being appended for purposes of comparison.

Months.	Minimum suspended 3 feet above ground, freely exposed.		Minimum under Screen.	
	Mean.	Lowest.	Mean.	Lowest.
	°	°	°	°
December	30·0	20·0	31·7	21·9
January	32·5	25·3	34·6	28·2
February	38·2	32·2	40·6	32·9
March	41·6	34·0	43·7	34·7
April	46·5	39·0	47·7	41·5
Mean	37·8	30·2	39·7	31·8

It will be observed from this table that the mean temperature a person would be exposed to out-of-doors three feet above ground at the coldest time of the night would be lower by about 2° than if that person was perfectly

sheltered from radiation, though freely in contact with the atmosphere. This atmospheric temperature fell below 32° in December only. In January it was just above 32°.

Temperature of the Sea.—A thermometer with a small trough was used, so that the bulb continued in the water while its temperature was being read. The instrument was either lowered into the sea from rocks, or let down, hanging to a string, from a wooden pier used for bathing; the immersion was repeated several times for each observation to a depth of about one or two feet, and care was taken to wait until the reading was steady before noting it. I have added to this table the mean temperature of the air, together with the mean minimum temperature.

Months.	Temperature of the Sea.							Temperature of the Air.	
	1874-75.	1875-76.	1876-77.	1877-78.	1878-79.	1879-80.	Means.	Mean.	Mean Minimum.
November ..	60°·4	61°·0	62°·0	63°·2	58°·3	61°·2	61°·0	52°·6	46°·5
December ..	55·6	57·0	59·5	58·3	56·6	55·8	57·1	46·3	40·1
January	55·8	55·7	57·1	55·9	55·4	54·6	55·7	48·0	42·0
February	54·5	54·6	56·2	56·7	55·7	55·4	55·5	48·8	42·1
March	55·8	55·8	56·3	57·2	58·1	57·1	56·7	51·0	44·4
April	58·5	59·4	59·8	60·4	58·4	59·5	59·3	55·5	49·1
Means	56·8	57·2	58·5	58·6	57·1	57·3	57·5	50·4	44·0

It will be observed from this table that the temperature of the surface of the sea is invariably higher than that of the air during the winter season, especially in December, when it exceeds the mean temperature by 10°·8, and the mean minimum by 17°·0. This shows to what extent the heat stored up by the Mediterranean in summer is available in winter as a means of checking the cold of the atmosphere.

Relative Humidity.—This was obtained by recording the simultaneous readings of a dry and a wet bulb thermometer, and calculating the percentage of saturation by means of Glaisher's "Hygrometrical Tables." If we con-

RELATIVE HUMIDITY.

Months.	1874-75.		1875-76.		1876-77.			1877-78.			1878-79.			1879-80.			Means.		
	9 a.m.	Mid-night.	9 a.m.	Mid-night.	9 a.m.	2 p.m.	Mid-night.	9 a.m.	2 p.m.	Mid-night.	9 a.m.	2 p.m.	Mid-night.	9 a.m.	2 p.m.	Mid-night.	9 a.m.	2 p.m.	Mid-night.
	o/o	o/o	o/o	o/o	o/o	o/o	o/o	o/o	o/o	o/o	o/o	o/o	o/o	o/o	o/o	o/o	o/o	o/o	o/o
ovember	68·6	70·8	69·9	72·2	69·2	64·5	72·6	76·7	69·8	76·7	70·8	68·1	73·8	72·3	69·2	78·0	71·2	67·9	74·0
ecember	86·7	81·4	72·0	74·3	74·0	72·3	75·2	70·3	65·9	76·1	73·8	71·6	73·3	65·5	62·2	70·6	72·7	68·0	75·1
nuary	75·1	76·8	68·9	74·5	69·8	65·5	70·9	70·6	64·8	73·2	74·7	69·3	78·2	71·2	65·7	75·1	71·7	66·3	74·8
bruary	75·8	76·4	71·0	74·6	69·2	67·0	69·4	79·2	73·5	82·4	78·0	69·8	75·2	77·0	70·0	83·8	75·0	70·1	77·0
arch ..	76·4	79·3	71·0	72·5	71·2	70·3	78·7	75·5	70·1	74·4	76·8	72·1	84·4	68·0	60·1	81·8	73·1	68·1	78·5
ril	73·8	84·5	76·9	80·6	71·2	65·6	75·1	79·0	74·2	82·3	75·1	71·0	78·2	70·0	69·8	80·0	74·3	70·1	80·1
leans ..	74·4	78·3	71·6	74·8	71·2	65·6	75·1	75·2	69·7	77·5	74·9	70·3	76·7	70·7	66·2	78·2	73·0	68·4	76·6

sider the minimum degree of relative humidity to be registered at 2 p.m., and the maximum at midnight, the mean of these two extremes will be 72·5, which is as near as possible the humidity recorded at 9 a.m. (73·0). A similar observation was made in my former paper, and there is little doubt that the relative humidity registered at 9 a.m., or at an hour not far from 9 o'clock, is at Cannes very nearly the mean degree of humidity of the 24 hours. A mean of 72·5 per cent. of relative humidity shows Cannes to be a comparatively dry place, notwithstanding its proximity to the sea. More moisture at night might have been expected, as the surface of the sea from its high temperature must be subjected to a considerable evaporation during the night, while the temperature of the air is low thereby detracting from its capacity for moisture. The increase of humidity at midnight is only, however, 8·6 per cent. beyond what it registers at 9 a.m., and 8·2 per cent. beyond the maximum state of dryness at 2 p.m. This may be accounted for from the heat absorbed by the earth during the day-time, which radiates into space at night, thereby increasing the capacity of the air for moisture.

Rainfall.—The rainfall and number of rainy days vary considerably from one season to another. The mean amount of rain that fell during the last four seasons was 20·31 ins., but there was only one-half that quantity in the six winter months 1879-80, when the weather was particularly fine. In the whole course of these observations the mean rainfall for each season ranged from 10·43 ins. to 32·92 ins. November, December and April exhibit the greatest rainfall and the highest number of rainy days. It must be recollected, however, that the rainfall is often made up of heavy showers after which the weather quickly brightens up. In winter rain falls more heavily at Cannes than in England, but during a much shorter time.

RAINFALL.

Months.	1876-77.		1877-78.		1878-79.		1879-80.		Means.	
	Rainfall.	Rainy Days.	Rainfall.	Rainy Days.	Rainfall.	Rainy Days.	Rainfall.	Rainy Days.	Rainfall.	Rainy Days.
	Ins.		Ins.		Ins.		Ins.		Ins.	
November	3·843	9	6·527	10	7·154	14	3·171	9	5·174	10·5
December..	7·385	12	6·267	5	3·721	13	0·668	3	4·510	8·2
January ..	1·691	4	0·478	4	4·204	12	0·375	3	1·687	5·7
February ..	0·040	1	0·038	2	3·118	12	2·665	5	1·465	5·0
March	4·460	10	1·545	5	7·555	9	0·135	2	3·424	6·5
April	3·050	10	2·570	13	7·166	16	3·418	11	4·051	12·5
Total	20·469	46	17·425	39	32·918	76	10·432	33	20·311	48·4

The climate of the Rivière is indeed very different from that of England. An English winter means little or no sun and heavy masses of clouds rolling along usually from the SW; rain falls frequently, though not heavily, and the atmospheric moisture is always close to saturation. The winter climate of the Rivière affords an uninterrupted succession of bright sunny days,

and when the rain falls, which it certainly does occasionally, it comes down as already stated heavily at the time, but is usually of short duration.

Winds.—The next table shows the number of days, calm, with wind light to fresh, and strong to a gale. It is very difficult to give a correct idea of the distribution of the winds, as they often vary to a considerable extent throughout the day-time, and are different at night from what they have been

WINDS.

Months.	1874-75.			1875-76.			1876-77.		
	Calm.	Light to Fresh.	Strong to a Gale.	Calm.	Light to Fresh.	Strong to a Gale.	Calm.	Light to Fresh.	Strong to a Gale.
November	19	6	4	5	14	11	11	14	5
December	14	10	7	15	12	4	9	15	7
January	20	5	6	8	18	5	8	18	5
February	15	5	4	4	8	16	3	17	8
March	4	22	5	2	11	18	2	22	7
April	3	15	12	5	16	9	1	24	5
Total	75	67	38	39	79	63	34	110	37

Months.	1877-78.						1878-79.						1879-80.		
	Calm.		Light to Fresh.		Strong to a Gale.		Calm.		Light to Fresh.		Strong to a Gale.		Calm.	Light to Fresh.	Strong to a Gale.
	9 a.m.	2 p.m.	9 a.m.	2 p.m.	9 a.m.	2 p.m.	9 a.m.	2 p.m.	9 a.m.	2 p.m.	9 a.m.	2 p.m.			
November	17	6	10	16	3	6	17	9	8	16	5	5	8	17	5
December	18	9	11	18	2	3	13	14	13	12	5	5	9	17	5
January	15	6	14	22	2	2	18	6	10	20	3	5	14	11	6
February	22	2	6	22	0	3	18	8	4	15	6	5	11	17	1
March ..	16	0	12	19	3	12	18	1	12	26	1	3	4	22	5
April	17	2	12	23	1	4	11	1	15	21	4	9	2	19	9
Total ..	105	25	65	120	11	30	95	39	62	110	24	32	48	103	31

GENERAL MEANS FOR FOUR SEASONS.

Days Calm	49
Wind Light to Fresh	90
„ Strong to a Gale	42

during the day. The observations made in 1877-78 and 1878-79 give the winds as they were recorded at 9 a.m., 2 p.m., and midnight, which is much more satisfactory than by making general statements. By such means I am able to show that the winds were distributed as follows throughout the 24 hours during the two seasons :—

Season.	Number of Days								
	Calm.			Light to Fresh.			Strong to a Gale.		
	9 a.m.	2 p.m.	Midnt.	9 a.m.	2 p.m.	Midnt.	9 a.m.	2 p.m.	Midnt.
1877-78	105	25	119	65	120	51	11	30	11
1878-79	95	39	109	62	110	60	24	32	12
Means	100	32	114	63	115	55	17	31	11

(No observations on six days at 2 p.m.)

It is interesting to remark that the air as a rule was calm at 9 a.m.; on the 181 days of each season a mean of 100 calm days was observed at that hour. At 10 or 11 a.m. a breeze usually rises, blowing in general from the S or SE when the weather is set fair, veering in the evening to the SW, and falling at sunset; while there was a mean of only 82 calm days, at 2 p.m. we find 115 days with the wind from light to fresh. We observe a large proportion of calm nights amounting to 114, while fewer strong winds and gales are registered at night than in the daytime.

There are comparatively few days on which the wind blew strong to a gale, their mean number is 17 at 9 a.m., 81 at 2 p.m., and 11 at midnight. It may, therefore, be concluded that gales are more prevalent during the afternoon than in the morning, and at night; they sometimes continue in the night, moderating for an hour or so, and rising again. It is nearly impossible to give a satisfactory account of the mean direction of the winds; the wet winds are from the NE, E and SE; the dry winds from the W and NW, especially from the latter direction. It frequently happens that the NW wind, or mistral, commences from the SW and gradually veers round to the W and NW. Its approach may often be foretold by the breakers visible at some distance from the coast, as the wind sweeps round the promontory formed by the chain of the Esterel Hills. The course of this wind has been often attempted, but it is difficult to do so. I tried at one time to follow its track by comparing my observations at Cannes with those made at other stations in a north-westerly direction, but the results were not satisfactory. It is a very dry wind, as I pointed out in my former communication, and is often strong to a gale.

The monthly distribution of the winds shows that they blow stronger and that there are most gales in February, March and April; while in November, December and January the mean number of days per month attended with high winds and gales was 19·5, during the other three months the corresponding mean figure was 25. Winds light to fresh are prevalent in March and April.

Storms with thunder and lightning are met with occasionally during the winter season, especially in the S, E and SE directions. A thunderstorm is often followed by an improvement in the weather after a succession of rainy days, but the surest sign of a return of the fine weather is a change of the

wind from E to W or NW, when, in the course of perhaps less than half an hour the sky is not unlikely to have cleared in a great measure.

Hail and Snow.—There are occasionally heavy showers of hail, but snow falls very seldom and is looked upon as an extraordinary phenomenon. On February 17th, 1875, at 10.30 a.m., there was a hailstorm with thunder; snow began to fall at 6.45 p.m. that same day, attended with lightning and thunder, and by 11.30 p.m. there was 1·2 inches of snow on the hard high road, while snow was still coming down. The next morning snow and rain set in together, and the country exhibited the most unusual appearance of a real winter landscape. The phenomenon was remarkable from its being accompanied with lightning and thunder. In the season 1876-77 no snow fell, and there was but a sprinkling in 1877-78, on March 17th. There was an absence of snow at Cannes in 1878-79; in the season 1879-80, on the morning of December 1st, a light coating of snow was observed on the grass, not deep enough to cover the grass blades. It is not uncommon to see snow on the hills at the back of Cannes, although seldom reaching so low down as the town of Grasse, 1,000 feet above the sea, where the olive tree thrives and where a lofty palm tree may be seen amongst the houses.

To sum up the contents of the present communication in a few lines. In November and part of December the weather at Cannes is usually stormy and wet. January and February are fine, with occasional visits of the dry north-west or mistral wind. During those two months the air is usually calm in the morning, about 10 a.m. a light and pleasant SE breeze begins to blow, increasing after noon, then veering to the S and SW and falling at sunset; this is followed by a light breeze from the N or NE, blowing overland towards the sea and continued long after sunset.

In December, January and part of February the nights are cool, the grass may be occasionally seen covered with hoar-frost in the early morning, and a thin sheet of ice may form on the road puddles; but wherever the sun's rays can reach the ice is melted by noon. In certain places, with a northerly aspect and screened from the sun, ice may remain all day long and even acquire a quarter of an inch in thickness and perhaps more in the coldest seasons. I have often observed the mud frozen and ice on the roads some little distance, say a quarter of a mile, from the sea, while the road was quite soft and there was no ice at all at the immediate seaside.

Hailstorms are sometimes observed, and snow may be expected about once every other year, when its quantity will be but small, and it will disappear in the day-time within a few hours. Notwithstanding the windy and showery character of March and April, there is a freshness in the air at that time of the season most pleasant to invalids. April may begin to feel warm, especially the latter half; and the temperature continues to rise in May, although the breeze and occasional showers assist in cooling the weather. Many of the English colony at Cannes who live there in their own houses speak of May in glowing terms.

I thought it would be of interest to observe how far the weather-forecasts from New York were realised on the Mediterranean coast of

the Rivière, and I cut out of the *Times* newspaper every one of them for the winter season 1879-80. Most of these despatches related to the French as well as the British coast, in a few of them the French coast was not noticed. The following table shows the state of the weather at Cannes on those days when gales or strong winds were announced from the United States. It will be observed that during the six months 37 forecasts were telegraphed from New York, out of which 18, or 48·6 per cent., turned out successful.

CABLE MESSAGES.	CORRESPONDING WEATHER AT CANNES.
NOVEMBER.	
3rd to 5th French Coast	3rd. A strong gale from ENE
8th ,, 10th British and Norwegian only	Calm, or very light breeze; strong mistral reported at Marseilles on 11th.
16th ,, 20th French	Fine, calm or light breeze
23rd ,, 25th French	21st. Gale from E with rain
29th ,, 30th British and Norwegian only	Rain, no wind
DECEMBER.	
30th Nov. to 2nd Dec. British & Norwegian	Gale from NW on 1st with rain
3rd to 5th French	3rd. Strong wind from NE, light snow shower.
11th ,, 13th French	13th. Strong E wind
16th ,, 18th French	Fine weather, calm
21st ,, 23rd French	Calm and fine
24th ,, 26th French	Calm and fine
JANUARY.	
27th Dec. to 2nd Jan. French	Calm and fine
4th to 6th French	Calm and fine
7th ,, 9th British and Norwegian only	Calm and fine
12th French	Light breeze, fine
14th ,, 16th British and Norwegian only	Calm and fine
18th ,, 20th French	Light breeze and fine
23rd ,, 25th French	23rd. NE strong, rain
25th ,, 27th British and Norwegian only	26th. Gale from E to ENE lasting three days
28th ,, 30th French	29th to 30th. E, strong
FEBRUARY.	
2nd to 4th French	Calm and fine
4th ,, 6th French	Calm and fine
7th ,, 9th French	10th. NE, strong rain, bad weather
13th ,, 15th British and Norwegian only	Calm and fine
16th ,, 18th French	18th. Mistral (NW) moderate fine weather, strong at sea; on the 23rd a thunderstorm with hail & E wind
Very bad weather announced.	
MARCH.	
5th to 7th French	Very light breeze, fine
9th ,, 11th French	9th. Strong SE, fine
12th ,, 14th French	Light breeze, fine
14th ,, 16th French	Cloudy, calm
21st ,, 23rd French	Gale, 22nd and 24th from NE, and fine weather
24th ,, 26th French Gale with rain and possible snow.	Strong breeze from E, SE & NE, fine
29th to 31st French	29th. NE strong, fine

CABLE MESSAGES.	CORRESPONDING WEATHER AT CANNES.
APRIL.	
1st to 3rd French	3rd. Strong S, fine
10th „ 12th French	Fine, calm
15th „ 17th British and Norwegian only	15th. A strong gale from E, rain
22nd „ 24th French	Calm and fine
27th „ 29th British and Norwegian only	26th. Gale from E. 27th. High wind, raining. 28th. Rain. 29th. Fine and windy, and 30th, a tremendous thunder-storm.

DISCUSSION.

Dr. WILLIAMS said that the Mediterranean was the great warming influence in the climate of Cannes; for he had observed the results of inland and sea-side stations, and had noticed that often there was frozen mud inland while there were no signs of frost at the sea-side. He had also remarked how vegetation throve along the whole coast of the Mediterranean, the finest and largest trees being close to the shore, where he had seen palms, heaths, and Aleppo and umbrella pines growing. The sun and the Mediterranean were the two factors of the Riviera climate, and acted as a "warming apparatus," the former giving direct radiant heat by day, and the latter equalising extremes and preventing the evil effects of the action of nocturnal radiation. The Mediterranean was a warm sea, seldom falling below 60° Fah. in winter to a depth of 20 fathoms, and was less influenced by changes of seasons than the Atlantic.

REPORT ON THE PHENOLOGICAL OBSERVATIONS FOR THE YEAR 1881. By the Rev. THOMAS ARTHUR PRESTON, M.A., F.M.S.

[Read December 21st, 1881.]

AN unusually large number of complete returns have been sent in this year, and very few changes have taken place amongst the former staff of observers. Miss Chapman has removed from English Bicknor, and her place has been supplied by Miss Annie Machen. Mr. W. H. Jones, who formerly sent observations from Uppingham, is now located at Malvern, and as he still continues to take observations, we have an additional Station there, as well as the former one at Uppingham, where the observations are now taken by Mr. C. H. Hinton. Three other Stations have been added, one at Croydon, one at Cullompton in Devonshire, and one, quite recently, at Northiam in Sussex. The long series of observations, which necessarily becomes more accurate every year, from the greater amount of practice, renders it desirable to classify the returns—for where spasmodic attempts are made to take observations, the results, though of some value, are not comparable with those of observers who regularly and systematically keep records.

In some cases there is still too much vagueness in the entries, and as an observer can more easily estimate the probable date of the flowering of a plant when he has missed the first date, it would be as well if such date were entered instead of the terms originally suggested, which appear to be often unknown and to lead to considerable doubt. "May 16, about a fort-

night" is easily understood—but "full bloom by May 16" leaves but a vague impression in the recorder's mind. I would therefore, ask observers to give as nearly as they can the date on which any particular species is computed by them to have come into flower, should they have missed the date of first flowering; of course, noting that the date so entered is estimated.

The most marked meteorological features during the last Phenological year, from October 1st, 1880, to September 30th, 1881, in central and southern England, were the very cold October, January and February; an ungenial spring accompanied by long continued drought, an extremely hot period in July, and a drenching August. The temperature throughout the year has been considerably below the mean (at Marlborough during 1881 we have only had 6 weeks, at scattered intervals, with a temperature above the average), and these extremes of heat and cold, drought and wet, have produced a corresponding effect upon animal and vegetable life. The snow in October, falling as it did upon trees with their full complement of leaves, did enormous damage by breaking off the boughs by its weight; whilst that in January, where it was able to remain on the plants, served as a protection from the severe cold; in fact, it may be stated roughly, that wherever trees and shrubs were not protected either artificially or by this natural protection of snow, they were, if not indigenous, almost invariably killed entirely, or down to the ground, and even among our native shrubs, some, more especially the gorse, were more than half killed. At Belton "Oak trees suffered considerably, many having large branches killed, many Lombardy Poplars were killed, and others so much injured as afterwards to show only a few little tufts of leaves at the top. All shrubs of the *Laurustinus* were completely killed, as also many large Box trees, Yew trees, Privet bushes, Cedars, and young Laurels. All large Laurels, and Portugal Laurels (except those in very sheltered situations), had been killed to the ground in the winter of 1879-80, but had succeeded in throwing up strong young shoots during the next summer; these shoots were completely killed, and only a few small buds told that life still lingered in the roots. *Berberis ilicifolia* was much cut up, and *Berberis Darwinii* entirely destroyed. Ivy was injured in every kind of situation, and whether on walls having a warm or cold aspect, or on trees, or covering the ground, large masses of this beautiful climber were killed." Such complete destruction was not, however, universal, for at Lincoln, an observer states, "here and there a Laurel has been nipped, but the Holly, Ivy, and Privet have not suffered in the least, nor has the Yew." In fact, it may be observed, once for all, that no single description of the weather will serve for the *whole* of England—the severe snowstorm in January, for instance, affecting only the southern counties, and the great heat in July not being at all experienced in the north—and my remarks, therefore, must be taken as applying only to those places from which returns have been sent.

The protection afforded by the snow was very marked. At Isleworth "the Rhubarb protected by large pots had hardly grown at all (by January 30), but the heads were coming up well *outside* the pots where protected by the snow." The mild December had brought on the early spring plants,

Snowdrops showing bud even as early as December 16th at Isleworth. The warm covering of snow prevented their being injured, and on its departure, vegetation as a rule was bright and green, and wild flowers were more than usually plentiful, and in the beginning of February, when there was a short spell of milder weather, the rapidity with which Aconites and Snowdrops came into flower was most unusual. Some observers declare that the plants grew and flowered under the snow.

[At Marlborough an Aconite was only just above the ground on February 2nd, but was in flower on the 4th; and at Lewisham, the first Snowdrop bloomed on February 3rd, by 1 p.m. 9 had their heads down, and on the morning of the 4th 45 were in flower.]

Ground vegetation, therefore, cannot be said to have suffered by the severe cold, the damage caused by that being confined to trees and shrubs, from off which the snow was blown; but the subsequent ungenial weather, coupled with a long continuance of drought, checked growth and certainly weakened it. Corn, for instance, did not send up the usual amount of stems, and fine as it looked later on, there was a thinness about the crop which indicated a serious diminution in the probable yield. The Grass, too, would not grow, and though the hay crop was successfully harvested, it was not nearly as plentiful, especially in high lands, as it would have been had there been a little more rain and growing weather. The root crops, however, suffered most severely, the young plants could not grow, and being weak, fell rapidly before the attacks of insect 'pests,' which were unusually numerous this year; details, however, of this are given in the Entomological Report. Farmers, therefore, though they were able to work the land properly, suffered some inconvenience by the destruction of their root crops and diminished produce of the hay fields, but were looking forward to a good corn harvest, and thus making up for the badness of past seasons. Quite towards the end of July rain fell, very beneficial to the root crops and cereals. In the early part of August there was fine ripening weather, and the crops promised to be above the average in yield, and when harvest began nothing seemed needed but a continuation of the fine sunny days. "By the middle of the month, however, the rain fell heavily in frequent and long-continued showers, and the intermittent gleams of sunshine did not last long enough to make the standing crops fit for cutting, or the cut crops fit for stacking. The heavily eared grain was beaten down, and sprouting was perceptible on the shocks." The low temperature, it is true, checked the growth, but the continued wettings caused a large part of the grain to fall from the ear as soon as the shocks were moved for carrying.

But a bad corn year is a good one for root crops, and the wet weather brought with it a vast improvement in this particular, so that, at the end of the season, farmers could say that except a partially light hay crop and an inferior corn crop, they had nothing to complain of.

Fruits generally seem to have been plentiful, but reports vary very greatly. Gooseberries and Currants were in many places almost ruined by the attacks of insects, and Strawberries were not up to the mark. Wall fruit was much

damaged by some early frosts and by the subsequent drought, but Plums appear to have been abundant in most places. There was a large show of bloom, and in districts where bees were kept there was a corresponding "glut" of honey, the succeeding crop of Apples and Pears being very satisfactory.

In connection with this glut of honey a very curious circumstance occurred. During its continuance the workers were busily employed in collecting honey and had no time to attend to the brood, consequently the queens ceased laying. The subsequent drought dried up the plants, so that the bees were unable to collect the proper quantity of food, nor did the queens seem inclined to resume laying. The consequence was that in the latter part of the season, when hives ought to be full of brood with plenty of food for the winter, there was hardly any brood at all in many hives, and the subsequent destruction of the swarms during the winter seems inevitable. In some districts not a square inch of brood-comb could be found in any of the hives.

Wild Flowers were generally later than last year, and until the beginning of June they were later than their average; after the first week in July they were much before their usual time. About Marlborough Trees and Shrubs are almost invariably late, as much as a fortnight or three weeks later than their average time of flowering. Grasses and water plants were also generally later, but there were a few exceptions. Wood plants and those growing in sheltered hedges were generally before their mean. According to the *Natural History Journal*, "the North is, this year, 24 days behind the South, and the average date of flowering three weeks later than 1878, and two weeks later than 1879."

October 1880 was one of the very coldest experienced during the present century. The first half of the month was generally wet, especially in the South of England—the second half was extremely cold, and snow fell heavily in some places. On the 20th a severe frost entirely killed down all tender garden plants and defoliated the Mulberry and Ash. Autumnal tints began to prevail about the middle of the month, and by the end Oaks, Beeches and Elms were the only trees in fairly full leaf. Berries generally were very scarce, and wild flowers, after the frost, were perceptibly diminished in numbers, though still fairly plentiful. The Swallow tribe remained long after their usual time. In the north of England October 23rd is almost the last date on which they were seen, but in the south Swallows and Martins did not leave till nearly the middle of November.

The first and third weeks of November were cold, but otherwise the weather was mild for the rest of the year. During the first half of November trees rapidly lost their leaves, and at Marlborough were almost entirely stripped by the rough winds and rains of the 13th and 14th. At Trusham autumnal tints were finest about the 6th and 7th, and at Isleworth, Beeches, Oaks and Elms were still beautifully bright on the 16th, and were not defoliated till the 30th. At Parbold several Oaks were green and trees finely tinted as late as the 4th. Wild flowers were still numerous, though not as plentiful as in former years. At Geldeston and elsewhere Ragwort, Bush Vetch,

Mouse-ear, Hawkweed, Herb Robert, &c., were in fine condition. Hazel Catkins were generally very promising, and *Laurustinus* and such other plants as had survived the last winter began to flower on the 18th.

DECEMBER was mild, and vegetation was forward for the time of year, Spring flowers appearing, and the buds on Oaks and other trees swelling. At Salisbury the Willow Catkins were bursting and Elder in leaf on the 27th, and the Hazel in flower before the 31st. At Farley the Herb Robert was still in full bloom. At Harpenden the Dog's Mercury was found in flower towards the end of the month in sheltered places, and Primroses were conspicuous for their numbers. At Trusham 42 species were found in flower during the first 10 days, and at Yeovil 37 between the 28th and 31st.

The mild weather lasted till JANUARY 7th, when an extremely cold period set in. The snowstorm on the 18th is too well known to need further notice. The destruction to Bird life was most painful. On the melting of the snow they were picked up in large numbers in some places, especially near stacks, where they had been driven by the wind and then snowed up. The general effect to vegetation has been mentioned elsewhere; at Geldeston Laurels had not suffered to anything like the extent they did this year since the spring of 1860.

FEBRUARY was a "very wet, cold and gloomy month, with frequent falls of snow," and consequently vegetation progressed very slowly indeed. "There was nothing to record"—"Vegetation much more backward than last year" is the general style of the Phenological Report for this month.

In MARCH the weather was genial from the 4th to the 20th, but cold at other times, with a bitter wind which damaged the few spring flowers that had appeared. Hepaticas especially suffered. At Chester "vegetation was at a complete standstill from the 19th, and as late as April 10th it was difficult to find a daisy." At Great Cotes "vegetation was remarkably backward and very slight appearances of spring up to the end of the month." At Isleworth, on the 12th, "the trees were evidently starting into growth," and on the 25th "vegetation was progressing steadily;" and at Babbacombe, "in the mild weather from the 5th to the 20th, vegetation made rapid progress, but was checked by the return of cold weather." About the second week began a long period of dry weather, lasting till the beginning of June.

APRIL was again an ungenial month, cold, except from the 10th to the 18th, and dry with much E wind; consequently "vegetation was completely at a standstill" was the universal remark of the observers. At Hertford the Ash was very generally in flower on the 4th, but the Oak had scarcely made any advance, but by the end of the month they had burst their buds pretty generally. The show of fruit was also good, but the "coldness of the season affected the Cuckoo Flower and the Ragged Robin; being water-loving plants this shows that the sun had not shone much to raise the temperature." This same want of sun was also remarked at Salisbury, where the young leaves of the Herb Robert, of several Umbelliferæ and especially of the Cuckoo Flower retained their brown and red tints unusually long. The Ash seems to have flowered profusely everywhere, and the

subsequent fruit most abundant. With the return of cold weather on the 23rd "the seeds did not sprout kindly, and the seedlings just through the ground were checked by the cold and drought." Foliation, except in the case of the Horse Chestnut, progressed steadily at Isleworth.

May, except towards the end, was an ungenial month. The drought affected the Hay crop, but the bloom on flowering shrubs was wonderfully fine as long as it lasted, but in some cases it seemed to last only a few days. The Hawthorn flowered at Oxford as early as May 6th, at Isleworth on the 9th, and generally by May 14th or 15th; at Marlborough on the 17th, and at Bradenham not till the 23rd. The Horse Chestnut flowered at Oxford on the 5th, at Salisbury and Babbacombe on the 9th, at Marlborough on the 11th, and at Bradenham not till the 23rd. A severe frost on the 10th did much damage, especially to the fruit blossom. At Marlborough the young Oak leaves were terribly cut up, and for the rest of the summer the miserable appearance of the Oaks was the subject of very general remark. Insects, too, became very numerous, and the vegetation, weakened by want of rain, suffered much injury from them. The Wheat plants were healthy, but fears were entertained on account of the drought, and though the weather was very favourable for agricultural work, the want of food for the cattle was becoming serious.

Whilst, however, things were in this state in the South of England, reports from the northern stations were very different. At Colwyn Bay "vegetation made a great start after April 30th, and flowers appeared with great rapidity." At Parbold, "during the greater part of May, the weather was unusually settled and very warm till the last week in the month, when a doleful change occurred—the cold weather with east wind and hail returned, and continued (as regards the cold) till June 14th."

The Oak and Ash seem to have came into leaf nearly about the same time, the Oak slightly in advance. At Harpenden, however, the reverse was the case, the Ash being nearly a fortnight before the Oak; and at Cullompton the Oak was in leaf before the Ash. Leafage was *established* at Isleworth on the 20th, so much so as to be peculiarly noticeable.

June was a sunless month with changeable weather after the first few days, so that though agricultural operations could be carried on; vegetation was generally backward. [At Bocking, however, it was "quite as forward as the average."] The Hay harvest began on the 14th at Bocking, on the 24th at Isleworth, but not till the 29th at Babbacombe. At Isleworth the crop was "fairly thick and long," and here also vegetation of all kinds was good, following on the showery weather before the 24th.

The weather of July was most extraordinary. In the first part of the month the heat was unprecedentedly great in the south-south-east and east of England, whilst in Ireland, Wales, and Scotland it was peculiarly cold and wet. And, secondly, "the recurrence on at least one night of a sharp grass frost at some of the inland stations." The Hay harvest (in the south of England) was well secured, though light; and the heat was very beneficial to the Wheat crops, which began to be cut on the 27th at Isleworth, but

earlier in other parts. The crops varied a good deal, the general complaint being that there were not the usual number of stems to each plant. Barley was in want of rain, and the Oat crop was a failure from the drought—but the latter in the humid climate of Ireland, Scotland, and north and north-west of England looked very promising.

Wild flowers were plentiful, and in many places flowered luxuriantly. The Ragged Robin was especially luxuriant at Northiam, a strange contrast to what occurred at Great Cotes; but it, as well as the flowering of the crops, was soon over, owing to the great heat, which also dried up the grass so that "the ground was so dry on the pasture land in Osterly Park (Isleworth) that the dust rose from the sward beneath the feet of a galloping horse as if from a dry road."

The drenching weather of August has been already referred to, and the serious effect produced on the crops. Haymaking was still in progress in Scotland as late as the 25th. At Babbacombe the Wheat harvest was generally finished by the 20th, and Barley cut on the 27th. Vegetation began to sprout again, and "second flowerings" were very general, so that the country began to assume a more lively appearance. The Potato disease was first noticed at Isleworth on August 24th, and by the 28th had spread in the same patches rapidly. On September 2nd Grapes in vineries that had no artificial heat had stopped colouring, and the stems in the bunches were in many cases shrinking.

With September came a change for the better, and the harvest was completed under favourable circumstances. The root crops were very fine, and the amount of berries and other wild fruits was astonishing. Many Ash trees were laden with "keys," and the Hawthorns were perfectly brilliant with the great abundance of "haws." Acorns were plentiful in many places, but very scarce in others, and leaf-galls of various kinds were uncommonly plentiful in the hedges.

Limes began to change at Isleworth by August 17th, and were regularly changing by September 2nd, and about a third defoliated by the 22nd. The first yellow patches in Elms were visible on the 3rd; Horse Chestnuts, Hawthorns, Beech and Oak about the middle of the month; and Birch partially changed on the 26th. But the *general* tone of the foliage throughout the country seems to have been still green at the end of the month.

At Maker the observer remarks, "This is the first year since I have been here (9 years) that the Spanish Chestnut has failed to ripen good-sized nuts. Even in 1879 there was a good crop, though of small size: this year *not one* that can be eaten."

NOTES ON THE SEVERAL SPECIES.

8. *Draba verna*. English Bicknor: abundant April 14.
10. *Polygala vulgaris*. Isleworth: in flower May 31.
15. *Hypericum pulchrum*. Isleworth: in flower July 29.
17. *Trifolium repens*. English Bicknor: well out June 4.
20. *Vicia sepium*. Cullompton: very late date.
21. *Lathyrus pratensis*. Cullompton: very late date.

No.	Plant.	Babbacombe.	Totnes.	Trusham.	Westward Ho.	Cullompton.	Yeovil.	Wincanton.	Salisbury.	Strathfield Turgiss.	Marlborough.	Isleworth.	Croydon.	Sawbridgeworth.	Ware.	Watford.	Malvern.	Oxford.	Bradenham.	Cardington.	Bocking.	English Bicknor.	Belton.	Geldeston.	Hatton.	Great Cotes.	Middleton-in-Teesdale.
1	ANEMONE NEMOROSA	..	65	84	..	..	77	95	73	107	75	87	79	..	79	79	77	75	..	69	91	68	86	97	103	95	93
2	RANUNCULUS FICARIA	74	45	47	56	48	47	2	47	69	56	75	58	..	75	67	71	56	60	76	78	68	77	57	85	67	87
3	*Ranunculus acris*	126	108	129	124	126	111	109	125	..	123	121	114	..	128	123	..	119	126	106	143	138	..	145	144	132	148
4	CALTHA PALUSTRIS	76	87	..	93	98	77	96	85	82	67	117	68	..	120	..	89	75	..	84	105	104	103	68	115	104	74
5	*Papaver Rhœas*	157	161	146	148	161	..	165	158	..	160	159	161	159	162	152	163	152	164	157	188	183	163	158	..	165	197
6	*Cardamine hirsuta*	78	..	29	52	64	55	70	70	..	67	80	86	..	..	..	73	75	..	60	..	..	88	..	92	..	87
7	*Cardamine pratensis*	103	104	95	99	105	104	105	99	105	96	113	113	116	117	109	104	115	114	108	103	103	117	118	120	126	132
8	*Draba verna*	80	..	48	80	..	40	71	46	102	60	76	71	..	..	..	..	41	..	60	..	n	..	69	97	..	118
9	*Viola odorata*	68	47	47	62	82	71	65	74	66	73	90	72	..	..	65	72	78	77	73	89	68	79	..	85	78	100
10	*Polygala vulgaris*	..	..	124	105	..	131	128	110	161	129	n	135	..	..	..	127	126	144	152	..	140	178	..	160	173	156
11	*Lychnis Flos-cuculi*	145	139	144	138	154	..	146	141	135	150	146	..	157	..	154	145	145	..	142	..	163	152	145	161	155	171
12	*Stellaria Holostea*	96	80	80	94	93	89	109	104	103	108	113	107	..	108	102	106	115	115	121	106	113	130	107	125	137	141
13	MALVA SYLVESTRIS	160	163	153	146	161	..	163	165	164	158	161	162	151	155	160	157	160	162	158	190	156	..	150	..	167	232
14	*Hypericum tetrapterum*	192	..	193	195	209	..	205	186	..	188	199	183	..	..	..	184	..	..	..	..	..	..	179	..	201	188
15	*Hypericum pulchrum*	186	..	167	162	175	..	185	179	..	179	n	..	..	..	176	188	..	..	..	..	..	..	..	..	191	187
16	GERANIUM ROBERTIANUM	118	110	108	105	142	131	122	124	125	128	140	128	133	134	128	123	123	133	141	143	128	142	138	..	141	147
17	TRIFOLIUM REPENS	159	137	132	130	154	131	137	146	134	146	142	148	143	149	142	138	126	148	147	145	n	146	141	156	152	170
18	*Lotus corniculatus*	137	132	127	123	138	130	122	128	..	137	..	124	144	149	149	136	129	144	146	141	123	145	145	156	150	148
19	*Vicia Cracca*	186	166	165	149	170	..	164	164	..	174	162	168	174	..	..	164	161	..	171	167	178	178	179	158	169	174
20	*Vicia sepium*	129	112	108	127	(171)	119	109	115	..	115	142	127	120	123	125	110	115	131	..	121	115	144	131	..	..	143
21	*Lathyrus pratensis*	153	144	145	144	(171)	..	153	146	..	149	162	162	155	162	153	..	152	164	159	147	155	173	161	156	157	168
22	PRUNUS SPINOSA	102	..	83	99	108	106	108	91	106	108	114	99	..	107	105	106	112	109	103	110	111	119	n	121	130	134
23	*Spiræa Ulmaria*	183	168	169	165	164	..	166	165	178	169	180	..	174	181	..	175	161	..	169	172	177	182	178	..	178	183
24	*Potentilla anserina*	139	123	129	123	161	125	134	125	135	139	140	134	142	137	149	141	130	..	135	147	142	153	145	147	148	155
25	*Potentilla Fragariastrum*	76	43	n	55	67	69	73	42	65	n	100	42	..	103	76	71	39	88	95	89	68	..	82	101	..	75
26	*Rosa canina*	164	152	146	143	163	..	163	155	157	156	166	162	161	162	156	152	160	164	160	162	n	163	164	164	175	182
27	*Epilobium hirsutum*	195	..	..	(181)	199	..	190	188	..	194	186	..	184	..	..	186	..	..	184	189	196	192	189	..	193	203
28	*Epilobium montanum*	..	181	160	150	165	..	155	165	..	155	159	..	163	..	161	..	160	..	165	163	172	175	167	..	..	172
29	*Angelica sylvestris*	..	..	..	197	207	..	208	205	..	193	207	207	..	..	..	212	..	..	201	230	..	..	n	..	..	173
30	*Anthriscus sylvestris*	..	97	..	99	133	97	105	102	115	109	117	117	105	109	113	..	112	115	111	114	116	..	109	129	134	..
31	HEDERA HELIX	266	..	268	270	282	..	262	256	..	275	268	264	..	..	251	272	..	..	246	254	..	..	..	..	..	..
32	*Galium Aparine*	145	139	132	127	138	129	132	141	143	130	142	142	134	134	135	..	133	164	134	140	n	142	n	161	157	166

No.	Plant.	Babbacombe.	Totnes.	Trusham.	Westward Ho.	Cullompton.	Yeovil.	Wincanton.	Salisbury.	Strathfield Turgiss.	Marlborough.	Isleworth.	Croydon.	Sawbridgeworth.	Ware.	Watford.	Malvern.	Oxford.	Bradenham.	Cardington.	Bocking.	English Bicknor.	Belton.	Geldeston.	Hatton.	Great Cotes.	Middleton-in-Teesdale.
37	TUSSILAGO FARFARA	76	80	67	65	90	68	50	68	61	57	72	64	..	71	71	68	70	..	69	89	n	78	70	76	79	71
38	ACHILLEA MILLEFOLIUM	180	165	165	156	171	..	187	165	168	149	172	..	175	..	171	164	161	186	170	180	176	184	177	..	191	173
39	*Chrysanthemum Leucanth.*	139	138	131	139	171	120	144	129	139	141	149	134	145	150	142	140	125	144	134	152	..	145	145	156	153	155
40	*Artemisia vulgaris*	..	..	..	200	208	..	228	199	..	220	204	198	215	..	212	230	..	..	:	..	..	195	201	..	219	224
41	*Senecio Jacobæa*	190	186	181	180	170	..	130	184	161	176	180	..	190	..	184	..	..	193	178	193	..	185	175	192	193	179
42	CENTAUREA NIGRA	194	185	153	(175)	164	..	171	171	159	182	169	168	172	175	175	162	161	180	163	182	n	184	173	..	179	188
43	*Carduus lanceolatus*	186	193	..	168	192	.	191	185	..	188	186	190	191	..	169	187	..	198	190	..	..	..	195	..	186	199
44	*Carduus arvensis*	186	175	175	172	194	..	184	175	..	188	182	..	..	..	..	184	..	185	177	189	183	..	..	..	178	188
45	*Sonchus arvensis*	..	..	188	183	..	..	195	204	..	188	202	203	..	..	..	211	168	192	184	..	..	..	239	..	168	221
46	*Hieracium Pilosella*	145	137	131	132	138	126	128	129	..	149	151	145	..	..	135	139	130	151	139	153	n	144	145	156	..	163
47	CAMPANULA ROTUNDIFOLIA	..	..	..	..	175	..	..	192	..	188	209	198	..	..	191	181	..	193	..	197	200	190	198	192	190	173
48	*Gentiana compestris*	..	..	.	144	..	..	..	..	..	n	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	207
49	CONVOLVULUS SEPIUM	201	171	186	168	194	..	191	180	..	187	183	198	185	188	..	186	..	201	184	190	..	189	..	..	193	..
50	*Symphytum officinale*	..	151	..	132	..	129	139	116	..	111	146	145	143	130	..	..	121	..	..	148	..	..	104	..	..	..
51	*Pedicularis sylvatica*	..	..	123	130	..	116	128	112	129	135	151	148	..	..	..	..	..	158	..	..	n	..	..	144	..	149
52	*Veronica Chamædrys*	113	106	106	132	99	89	105	99	98	116	117	118	..	122	123	111	114	126	121	119	n	..	121	132	121	148
53	*Veronica hederifolia*	70	..	31	..	69	71	69	60	..	n	76	58	..	..	..	n	37	..	69	..	..	76	75	..	..	126
54	*Mentha aquatica*	224	.	..	204	199	..	211	202	..	215	222	232	..	..	..	214	..	..	204	230	n	221	..	..	..	233
55	*Thymus Serpyllum*	164	180	..	161	..	..	203	158	..	158	..	155	..	..	..	151	164	186	166	..	n	163	..	..	..	174
56	*Prunella vulgaris*	176	170	156	161	171	..	168	172	..	176	173	..	168	..	171	159	161	155	163	168	n	170	173	..	..	175
57	*Nepeta Glechoma*	95	89	70	75	98	87	78	84	99	89	100	99	..	97	93	85	80	98	93	101	91	103	90	107	107	133
58	*Galeopsis Tetrahit*	..	..	188	188	215	..	211	n	..	188	..	..	..	..	..	179	..	201	..	..	..	..	..	..	..	210
59	*Stachys sylvatica*	..	..	149	151	170	..	157	155	155	165	159	162	155	155	161	162	152	164	159	154	n	176	167	..	..	181
60	*Ajuga reptans*	123	108	122	109	117	116	116	119	..	125	132	120	130	132	127	122	119	143	128	120	129	133	138	134	139	143
61	PRIMULA VERIS	102	..	..	125	117	85	81	89	99	96	107	99	..	78	77	89	115	102	96	90	n	116	106	104	117	110
62	*Plantago lanceolata*	117	105	105	102	99	108	116	112	..	117	121	114	116	124	114	111	115	127	108	125	n	127	128	132	136	143
63	*Mercurialis perennis*	94	..	32	50	64	70	68	46	69	41	88	58	..	71	40	61	47	65	85	70	68	..	72	..	..	88
64	*Ulmus montana*	83	..	70	..	..	75	69	72	(91)	78	84	79	..	..	..	..	74	..	77	88	..	..	..	n	..	..
65	*Salix caprea*	77	69	73	n	82	75	86	..	(66)	81	80	72	..	..	76	86	77	77	79	89	..	94	82	..	104	108
66	*Corylus Avellana*	69	25	11	49	48	47	57	n	n	37	41	37	..	(44)	37	51	37	65	60	45	n	..	54	70	..	69
67	*Orchis maculata*	179	161	..	173	164	..	152	151	..	158	..	162	..	165	159	..	161	..	161	..	158	175	n	159	169	164
68	*Iris Pseud-acorus*	162	143	..	139	154	..	173	150	..	154	162	139	159	155	154	158	150	..	156	162	..	154	..	159	165	175
69	*Narcissus Pseudo-narcissus*	..	63	(64)	66	71	87	68	74	73	71	n	..	..	(76)	71	75	78	..	83	..	..	..	..	91	104	100
70	*Galanthus nivalis*	..	32	36	..	33	41	33	31	32	34	36	..	..	(36)	..	..	..	..	29	39	..	35	38	56	.	53
71	*Endymion nutans*	116	104	98	120	121	106	109	106	117	107	121	120	..	120	109	92	115	119	..	..	104	137	122	125	134	126

TABLE II.

Average date of the Flowering of Plants for each year from 1875 to 1881.

No. and Name of Plant.	1875.	1876.	1877.	1878.	1879.	1880.	1881.
70. *Galanthus nivalis* (Snowdrop)	14	31	18	28	41	46	36
66. *Corylus Avellana* (Hazel)	13	24	12	34	39	57	41
2. RANUNCULUS FICARIA (Pilewort)	61	57	36	35	73	64	66
63. *Mercurialis perennis* (Dog's Mercury)	47	69	32	50	80	65	62
37. TUSSILAGO FARFARA (Coltsfoot)	72	62	51	53	66	61	70
25. *Potentilla Fragariastrum* (Barren Strawberry)	46	60	53	50	82	69	79
9. *Viola odorata* (Sweet Violet)	48	50	46	56	70	64	72
65. *Salix caprea* (Great Sallow)	75	70	58	64	81	76	79
69. *Narcissus Pseudo-narcissus* (Daffodil)	81	61	54	54	84	78	79
64. *Ulmus montana* (Wych Elm)	69	64	53	65	80	72	79
8. *Draba verna* (Whitlow Grass)	64	60	38	45	77	71	71
1. ANEMONE NEMOROSA (Wood Anemone)	87	81	78	66	88	75	85
4. CALTHA PALUSTRIS (Marsh Marigold)	95	74	63	62	84	84	92
57. *Nepeta Glechoma* (Ground Ivy)	100	92	91	74	101	86	93
22. PRUNUS SPINOSA (Blackthorn)	99	97	67	80	117	99	107
61. PRIMULA VERIS (Cowslip)	99	97	87	85	110	86	94
30. *Anthriscus sylvestris* (Cow Chervil)	86	106	95	78	127	110	114
7. *Cardamine pratensis* (Cuckoo-flower)	108	107	96	88	119	99	109
12. *Stellaria Holostea* (Greater Stitchwort)	111	103	84	97	126	106	107
71. *Endymion nutans* (Blue-bell)	110	114	109	105	132	113	115
52. *Veronica Chamædrys* (Germander Speedwell)	109	116	104	89	122	102	115
62. *Plantago lanceolata* (Ribwort Plantain)	118	110	112	113	131	114	117
3. *Ranunculus acris* (Upright Crowfoot)	119	114	112	100	137	113	125
60. *Ajuga reptans* (Bugle)	127	122	127	119	139	117	128
16. GERANIUM ROBERTIANUM (Herb Robert)	125	126	124	120	143	120	128
32. *Galium Aparine* (Cleavers)	128	146	144	134	155	142	143
17. TRIFOLIUM REPENS (Dutch Clover)	138	149	154	138	162	147	146
24. *Potentilla anserina* (Silver-weed)	146	145	152	131	151	128	138
18. *Lotus corniculatus* (Bird's-foot)	141	151	157	136	160	143	142
39. *Chrysanthemum Leucanthemum* (Ox-eye)	137	143	141	130	155	137	142
46. *Hieracium Pilosella* (Mouse-ear Hawkweed)	141	143	145	131	159	136	142
11. *Lychnis Flos-cuculi* (Ragged Robin)	137	153	156	139	164	146	148
21. *Lathyrus pratensis* (Meadow Vetchling)	154	164	167	157	169	153	156
5. *Papaver Rhœas* (Red Poppy)	145	152	160	154	175	167	156
68. *Iris Pseud-acorus* (Yellow Iris)	156	163	166	148	169	162	157
26. *Rosa canina* (Dog Rose)	157	164	165	151	178	162	159
13. MALVA SYLVESTRIS (Common Mallow)	158	169	169	160	180	168	160
59. *Stachys sylvatica* (Hedge Woundwort)	164	170	170	154	176	160	160
28. *Epilobium montanum* (Broad Willow-herb)	166	175	170	165	176	163	161
23. *Spiræa Ulmaria* (Meadow-sweet)	173	176	174	168	188	176	180
42. CENTAUREA NIGRA (Black Knapweed)	162	179	178	168	189	175	172
33. *Galium verum* (Yellow Bedstraw)	176	185	182	183	196	185	179
44. *Carduus arvensis* (Field Thistle)	178	182	183	176	202	183	179
45. *Sonchus arvensis* (Corn Sow-Thistle)	191	193	205	200	211	200	189
49. CONVOLVULUS SEPIUM (Greater Bindweed)	195	195	199	189	212	194	189

25. ***Potentilla Fragariastrum.*** **Trusham: by June 1. Marlborough: flower from November 29, 1880.**
26. ***Rosa canina.*** **English Bicknor: full bloom June 14.**
27. ***Epilobium hirsutum.*** **Westward Ho: very early specimen June 30.**
29. ***Angelica sylvestris.*** **Geldeston: central umbel in seed by August 29.**
32. ***Galium Aparine.*** **English Bicknor: plentiful June 12. Geldeston: fully out by May 25.**
33. ***Galium verum.*** **Westward Ho: at the sand hills June 8,—not generally out June 28.**
35. ***Scabiosa succisa.*** **Geldeston: evidently fully out by September 30.**
37. ***Tussilago Farfara.*** **English Bicknor: plentiful March 9 (in sheltered aspect).**
42. ***Centaurea nigra.*** **Westward Ho: very early specimen June 13, most in**

bud July 1. English Bicknor : one specimen June 8, no appearance of more buds.

46. *Hieracium Pilosella.* English Bicknor : plentiful June 7.
48. *Gentiana campestris.* Marlborough: full flower (about 10 days) September 29.
51. *Pedicularis sylvatica.* English Bicknor : well out May 10.
52. *Veronica Chamædrys.* English Bicknor : well out April 27.
53. *Vernonica hederifolia.* Marlborough : flowers from October 6, 1880. Malvern abundant March 12.
54. *Mentha Aquatica.* English Bicknor : full bloom August 20 (several fully out).
55. *Thymus Serpyllum.* English Bicknor : well out June 27.
56. *Prunella vulgaris.* English Bicknor : well out June 12.
58. *Galeopsis Tetrahit.* Salisbury : several flowers in seed, and secondary branches in flower July 23.
59. *Stachys sylvatica.* English Bicknor : plentiful June 8.
61. *Primula veris.* English Bicknor : well out April 14 (in a sheltered spot).
62. *Plantago lanceolata.* English Bicknor : several in flower May 3.
64. *Ulmus montana.* Strathfield Turgiss : "elm" in flower April 1. Hatton : elm in full flower April 12.
65. *Salix caprea.* Westward Ho : March 16, possibly *salix cinerea.* Strathfield Turgiss : in flower March 7.
66. *Corylus Avellana.* Salisbury : December 31, 1880, many out, male and female. Strathfield Turgiss : well out February 5. Ware : barely out February 13. English Bicknor : abundant March 6.
69. *Narcissus Pseudo-narcissus.* Trusham : opened in water March 5. Isleworth : in flower March 29. Ware : double var.
70. *Galanthus nivalis.* Ware : double var.

Foliation Return, Isleworth, 1881.

The dates of foliation of the trees observed in the neighbourhood of Isleworth in the year 1881 were on the whole later than those of 1880, and earlier than those of 1879, both as regards the commencement and the establishment of leafage, with the exception of the Ash, of which the leafage was rather earlier than that of 1880, and much earlier than that of 1879.

The following table gives the date of the first bursting of the buds; appearance of young leaves; leafage in sufficient amount to appear as sprinkled over the trees, and of leafage first seen to be fairly established in natural amount, though not yet full sized. The same trees are noticed as have been observed in previous years.

Tree.	Buds Bursting.	Young Leaves.	Sprinkled.	In Leaf.
Horse Chestnut	April 5	April 12	April 14	May 8
Sycamore	....	....	April 15	....
Hawthorn	March 15	April 5	April 12	April 27
Ash	May 1	May 5	May 13	May 20
Oak	April 27	May 8	May 12	May 20
Elm	April 14	April 18	April 27	May 20
Birch	....	April 15	April 18	May 8
Beech	May 1	May 1	May 5	May 20
Lime	April 14	....	May 1	May 20

Horse Chestnut leaf buds first began to open on April 5th, on one tree; the leafage progressed very slowly just before the 27th, when it was checked by cold, the readings of the minimum thermometer from the 21st to the 23rd ranging between 27°·0 and 30°·8, and (as in 1878) the foliation was observed to be rather less forward on the ordinary state of ground near Isleworth, than on trees quite close to the Thames. The flowering and the developed leafage of the Horse Chestnuts was luxuriant and healthy.

The only Sycamores that are observable are in such unnatural localities, from being in damp spots where they are much overhung or in full glare of reflected heat from the high road, that fair observations can hardly be taken; the instance given is of trees in both situations which were sprinkled with leafage about a third to half sized on April 15th, but on some other specimens the buds were only bursting and a small quantity of leafage beginning to expand on the 18th. Sycamore trees might be considered as in leaf on May 20th, in some cases. Hawthorn advanced slowly, but remarkably evenly, from the first leaf-buds, opening very slightly on March 15th, to a sprinkling of leafage about half an inch in length (without the footstalk) on April 12th, and to leafage on the 27th.

Ash trees were remarkably early; the first commencement of opening of the leaf-buds was observable on May 1st, and on the 20th the trees were in light leaf, the amount of advance of foliage noticeable in different localities on that day varying similarly with that of Oaks growing in the same circumstances, both kinds of trees being sometimes in light leafage, sometimes only sprinkled.

The Oak buds began to burst on April 18th and 27th, but on so very few trees that this could not be considered as fairly begun till May 1st, and the trees on the 12th were from lightly sprinkled with leafage just out of the bud to sprinkled with leaves grown to about a quarter of their natural size, and by the 20th light leafage was established.

The Elm hedges began to open their buds on April 5th, some days before those on the lower boughs of the trees, which I have taken the observation from in preference, the hedge growths not being in natural circumstance. The bursting of the buds on the trees began on April 14th, and the progress of foliation (as usual with this tree) spreading gradually upwards, the trees were decidedly sprinkled near the ground, and of a faint green tint all over, on April 27th, and in leaf on May 20th. The leafage, however, did not gain the true deep summer tint until (after thunder and heavy rain on May 28th, with some slight amount of rain just before) it turned very rapidly to a deep green.

The first leaves on the Birch were observable on April 15th, and the trees were in light leafage on May 8th.

On the Beech the first commencement of leafage was sudden, many buds were bursting, and a small quantity of leaves in their first stages also appeared on May 1st, and on the 20th the trees were in leaf.

Lime buds began to open on April 14th, the trees were sprinkled on May 1st, in leaf but not thickly so on the 20th,

Five kinds of the trees noticed were observable as "in leaf" on the above date, May 20th; Beech, Lime, and Elm being in about the same state of foliation, and also the earliest Oak and Ash trees advanced to the same amount, this development of foliage following on days with occasional rain-fall from the 15th to the 19th. The leafage was observable in the early summer for the slowness with which it gained its full colour, in the case of the Elm it gained the true tint after heavy rain on May 29th. Afterwards it was plentiful, and of good size and colour, excepting that of the Oaks, which was much injured by Lepidopterous Caterpillars, of which some were of *Tortrix viridana.*

Observations on the Trip from Isleworth to Reading, May 24th, 1881. By Miss E. A. Ormerod, F.M.S.

The trees observed this year on May 24th, on each side of the railway line from Isleworth to Reading, were for the most part either sprinkled with the commencement of leafage, or in light leaf. The foliation was in about the same state of advance as at the same date in 1880, and in some cases rather earlier, especially in regard to the leafage of the Ash, which was sprinkled on trees in the neighbourhood of Feltham, Ashford and Virginia Water, and well sprinkled near Wokingham.

Elm leafage was well established, though not fully coloured.

Oak was generally either sprinkled or in light leafage, excepting between Ascot and Bracknell, where the lower boughs had small amount of foliage, and also between Bracknell and Wokingham; but whether the bareness of the trees was from late foliation, or was the work of caterpillars, could not be ascertained in passing, but conjecturally the insect injury was the cause, as the Oak leafage is not markedly developed first at the upper part of the tree.

The shoots of the Spruce Fir near Egham were in very bad condition, but good near Reading.

Larch was in fine leafage, and Scotch Fir in good shoot near Ascot and Bracknell.

Leafage was for the most part healthy, and comparison of the details, shows the foliation (or shoot, as the case may be) of the Beech, Birch, Larch, and Pine to have been best in the district of which Ascot is the centre, and of the other trees the foliation was for the most part rather earlier on the Reading than on the Isleworth side of Ascot, excepting in the case of Horse Chestnuts, which were not noticeable to any extent after passing westwards from Sunningdale.

Gorse was so severely injured by the cold of last winter, that the large extent of discoloured bushes gave the appearance, (excepting from the stems being brown and not completely blackened), of the patches having been burned; this was especially noticeable on Hounslow Heath.

Hawthorn blossom was luxuriant, and the "first flowers" of the Pink variety were observable between Egham and Staines.

Buttercups were also in splendid blossom in the meadows; the Chervil, Ox Eye Daisies, Blue Bells, or Wild Hyacinth, Large Water Ranunculus or Meadow Bolts were in flower. The Scotch Fir was showing blossom, and the common Bracken Fern was in shoot; the amount of blossom was greatest towards Reading.

As far as the passing glance could show, the corn throughout the distance (excepting between Virginia Water and Egham, where some was good,) was usually rather poor, as if needing rain, the Clover and Peas sometimes good.

ENTOMOLOGICAL REPORT 1881. By Miss E. A. ORMEROD, F.M.S.

THIS year has been remarkable for a large amount of Insect presence. Some species that usually appear in moderate numbers have been unusually plentiful, and others that are rarely seen have been observed in injurious numbers; but no system of extended observation having been yet arranged for the guidance of contributors, we have no mention of these important attacks from the phenological observers, excepting a few notes of interest from Great Cotes and Marlborough, the other contributions being mainly records of appearance of nine of the ten species on the selected list.

The Turnip Flea Beetle (commonly known as the "Fly"), which was one great visitation of the season, is noted at Marlborough in May, as having completely cleared off three successive sowings of various kinds of Cabbage; and larger growths (such as Cabbage and Broccoli 6 inches high) were destroyed when planted out.

At Great Cotes the weather of July is noted as hot and dry, and the ravages of the Turnip Beetle as excessive in the lowlands in North Lincolnshire, and continuing unabated into the second week in August, consequently Turnips in the lowlands were almost a failure. On the "Wolds" the reverse was the case, there was little presence of "Fly," and a full crop of Turnips.

The Mangold crop is mentioned also at Great Cotes, as being in great part destroyed by the grub (? of *Anthomyia Betæ*), and many Bean crops quite destroyed by Aphides, several days in the month having been especially favourable to the development of this insect,—excessive heat by day, alternating with slight frosts at night.

Various kinds of Saw Flies were destructive near Marlborough. The Caterpillar of the Gooseberry Saw Fly is noted as injurious in May; on June 15th sprays were forwarded from Ogbourne Maizey, loaded with enormous quantities of Caterpillars of Pine Saw Fly, then doing much injury to Pine trees; and later in the year the very unusual circumstance of Saw Fly Caterpillar attack on wheat was noticed in a field in the same district.

At Colwyn Bay, Queen wasps were so numerous that on June 6th, 125 are recorded as having been killed in the space of an hour and a half on the blossoms of *Cotoneaster Microphylla*; these it is noted were in the following proportion to the hundred: of the ground wasps, *Vespa vulgaris*, 8; *v. Germanica*, 15; *V. rufa* (commonly less plentiful than the preceding), 65; of

the tree wasps: *V. sylvestris*, 7; *and V. Britannica* (*Norvegica*, Smith) 10; and mention is made of 2 specimens of *Vespa arborea*, a species of exceedingly rare appearance in England, being killed afterwards;—the list thus comprising all our *Vespidæ* excepting the Hornet, *Vespa Crabro*.

Mr. R. Service of Maxwelltown draws attention to the great abundance of Wasps in May, when the large females were as abundant as the workers are commonly in an August day, the temperature being for three weeks during May unusually high, with clear sunny days. With the change of the weather to cold, damp, sunless days during June and July the Wasps disappeared and as many as 50 workers were not observed during the season up to the date of communication, August 9th. The observer, who is well qualified to form an opinion, is inclined to think the females were abortive.

The small White Cabbage Butterfly was very abundant during May at Great Cotes, but specimens of the large White were not seen until June 19th, and this kind was extremely scarce there throughout the season. At Isleworth the small Whites were seen on April 13th, and were unusually plentiful during the summer.

The foliage of the Oaks was badly injured by Caterpillars in various places between Isleworth and Reading on May 24th, and the Oaks round Isleworth were injured throughout the season by various species of Lepidopterous Caterpillars, the common Leaf-roller, *Tortrix viridana*, being one, and much injury to Oak leafage was also recorded in the neighbourhood of Marlborough.

The remainder of the notes of the phenological observers refer mainly to dates of appearance, and are given in corresponding sequence under the name of the insect referred to, where sufficient observations have been sent in to make them of possible value for comparison.

No. 72. Common Cockchafer, *Melolontha vulgaris*. Strathfield Turgiss, April 6; Malvern and Totnes, May 22; Harpenden, May 23; Bradenham (Cockchafer), May 24; Belton, May 31; Isleworth, June 3.

73. Summer Cockchafer, *Rhizotrogus solstitialis*. No records.

74. Honey Bee, *Apis mellifica*. Odsey, January 31; Totnes, February 16; Ware, February 28; Strathfield Turgiss, March 2; Bradenham, Buntingford, Harpenden and Hertford, March 5; and second record at Ware also March 5; Belton, Cardington, Hatton and Throcking, March 6; Great Cotes, March 11; Salisbury, March 14 (? earliest); Parbold, April 14. (The Honey Bee is noted as still out in the autumn of 1880 at Trusham, on November 6, 8, and at Hatton on November 14).

75. Large White Cabbage Butterfly, *Pieris Brassicæ*. Ware, April 1; Harpenden, April 6; Hertford, April 7; Watford, April 15; Bushey, April 16; Redburn Bury, April 25; Salisbury, May 8; Strathfield Turgiss, May 9; St. Albans, May 11; Great Cotes, June 19.

76. Small White Cabbage Butterfly, *Pieris Rapæ*. Kimpton, March 16; Babbacombe, March 18; Totnes, March 28; Downside College, March 30; Cardington and Hertford, April 8; Bradenham, Malvern, Redburn Bury,

Ware, and Watford, April 10; Isleworth, April 13; Hatton, Salisbury and Strathfield Turgiss, April 14; Trusham, April 15; Throcking and West Denbigh, April 17; Maker, April 20; Great Cotes, April 25; Belton, April 26; Harpenden, May 28.

77. Meadow Brown Butterfly, *Epinephile Janira.* Hertford, May 24; Belton, June 2; Strathfield Turgiss, June 11; Colwyn Bay and Totnes, June 12; Malvern, June 22; Great Cotes, June 23; Isleworth, June 26; Babbacombe, July 14.

78. St. Mark's Fly, *Bibio Marci.* Watford, April 30.

79. Winter Gnat, *Trichocera hiemalis.* Watford, January 1; Trusham, January 6, 8, &c.; Burton-on-Trent, January 29; Isleworth, January 31; Hatton, March 6.

Brimstone Butterfly, *Gonopteryx Rhamni.* Strathfield Turgiss and Throcking, March 11; Bradenham, Hoddesden and Yeovil, March 16; Isleworth, May 7; Hatton, May 8.

Orange-tip Butterfly, *Euchloe Cardamines.* Trusham, March 15; Yeovil, April 28; Bradenham, May 7; Strathfield Turgiss, May 10; Hatton, May 11; Great Cotes, May 21; Hertford, May 24; Salisbury, May 31.

Small Tortoise-Shell Butterfly, *Vanessa Urticæ.* Downside College, March 7; Throcking, March 11; Bradenham and Yeovil, March 16; Isleworth, May 7.

The returns sent in from the country at large, accompanied in all doubtful cases by specimens, show that the great attack of this season has been that of Turnip Flea Beetle, commonly known as Turnip Fly, an insect which has been shown by the agricultural returns of many years to be most destructive in seasons of heat and drought. Notes sent in by Mr. Robert Service, of Maxwelltown, mention that in the Counties of Dumfries and Kircudbright the breadth of land in Turnips amounted in 1880 (according to the Government Book of Agricultural Returns) to 34,172 acres; of this, at a low estimate, 30,000 acres required to be sown a second time this year, which, according to the average price of seed and quantity used per acre, would amount to a loss of £4,500 in the article of seed alone irrespective of all other expenses, and gives some suggestion of the enormous loss that has been incurred this year.

Two kinds of Weevils, rarely very destructive, have also been at work. The *Ceutorhynchus cyanipennis* was as injurious as the "Fly" to Turnips in the district of Hawick until rain gave the plants a start, and in Caithness the *Ceutorhynchus contractus* was very injurious. More moisture has been needed for this crop, and, failing it, the growth was not enough to counterbalance the damage from pests.

Celery Fly, which has been very injurious for some years in the neighbourhood of Isleworth, has been little noticed this season. The weather during the early part of the growth was hot and dry, conjecturally not suitable for development of this Fly; and afterwards, coincidently with much rainfall, the crop grew with great vigour and rapidity.

Mangold Fly, *Anthomyia Betæ,* which first appeared in large amount last

season, has held its ground and is spreading; and the *Oscinis frit*, a most destructive Fly, was noticed in great numbers in Dorsetshire, and severe injury occasioned to young wheat near Tewkesbury by one corresponding in habits in its larva stage. Various kinds of Saw Flies have also been very injurious. The common Gooseberry Saw Fly, a pest which is always, and quite unnecessarily, present, appeared unusually early in the spring, and was bad in many places. A species of Saw-Fly, as yet undescribed, but apparently a *Dolerus*, appeared in large numbers on grass at Rochdale in Lancashire, and attacks of other kinds on Wheat, Pine and Oak have been reported.

The Antler Moth Caterpillars repeated their attacks of last year, and were clearing off fields of grass in Lancashire early in July, and throughout the season the foliage of Oaks has been ravaged in various places by the caterpillars of various moths—in some cases the well-known *Tortrix viridana*.

In Kent and Hants, the Hop Frog Fly, the *Euacanthus interruptus*, caused much damage, and besides other attacks, a new enemy to Potatoes appeared at Tullamore, in the King's County, where the caterpillar of a species of moth (apparently nearly allied to the common Turnip Moth) bored up the inside of the stems, causing the deaths of many plants.

The methods of prevention simply by agricultural treatment would be out of place here, but it may be allowed just to point to the main attacks of the three last years being either in coincidence with deficient or excessive rainfall, or influenced by it, the great attack of this year being, as it often is, in coincidence with heat and drought, and one which (by preserving moisture in the soil at sowing time time, &c.) it has been found to lie within our power to diminish. The great attack of last year—that of the *Tipulæ garvæ*, commonly known as Daddy Longlegs' grubs—is equally well known both to agriculturists and entomologists to follow, as it did then, on excess of rainfall, partly because the damp and the conditions of plant growth induced by it suits the insects, partly because the land cannot be thoroughly cultivated in these circumstances.

A year further back (in 1879), when the vast flight of the Silver Y Moth, *Plusia Gamma*, swept from the first point of observation on the North-west of Africa, between April 15th and 20th, and after crossing Spain and Italy spread through Germany and France, and reached our southern shore on June 10th, rain again acted powerfully, as recorded by Mr. Fitch, near Maldon, Essex, where the caterpillars were destroyed in enormous quantities during August by the great amount of rain before they had time to effect serious damage.

Similar observations are recorded more or less completely regarding effect of rainfall in its various phases of—too little; too much; and sudden downpour after drought: and if we could procure such records from observers, it might possibly lead to better regulation of the rain stores than to permit the alternate excesses.

Turnip Fly accompanies heat and drought or follows on these conditions, and how far it was influenced by preceding meteorological states, or was

affected by changes in the weather acting on the amount of propagation or indirectly by alteration of the suitableness of its food, would be desirable information.

Daddy Longlegs, or Crane Fly, is almost certainly a follower of excessive and prolonged rainfall. Notes of its relative amount of appearance in damp and shady, and dry and sunny spots, close by each other; reduction of its appearance by draining, &c., would be useful.

Wheat Midge depends very much for its power of harming us on the date of flowering of the wheat; if the Midge is out before flowering time, or its appearance is delayed till the embryo grain is too hard to suit the young larvæ, the crop is safe. This is worked practically in American and Canadian experiments, and two or three instances of it occurred here in 1879.

Onion Fly. Amount in different districts, with details.

Beet Fly has newly settled as a really injurious insect, and any observations as to its being checked by rain, which would set a vigorous flow of sap at work in the leafage, or any notes as to weather effects, would be desirable.

Celery Fly.—This conjecturally (from a few personal observations) depends much on weather. This year, after great heat in one district and checked growth, as soon as heavy rain set in the Celery grew rapidly and was little injured. If we could learn whether the heat and drought was unfavourable to hatching the Fly, or the excessive rainfall afterwards checked the insect by establishing a luxuriant juicy growth, such as is known to be often unfavourable to insect life, it would be good information.

Apple Weevil is particularly injurious to the buds in dull cloudy springs. The insect only lays in them whilst the petals are still folded, so that in sunny weather when the blooms open fast little damage occurs. This damp and shady state is produced artificially by overcrowding orchards, and any observations as to amount of presence and reasons would be useful.

Gooseberry Caterpillar.—Date of appearance in spring, &c.

Report on the Ornithological Observations, 1881. By John Cordeaux.

Observations have been received from 46 stations: 44 in England, 1 (Gresford) in North Wales, and 1 (Waterford) in Ireland.

In 1878, 21 stations sent in reports; in 1879, 25; in 1880, 32; and in 1881, 46. This shows a satisfactory and steady increase.

For the convenience of the reader the results are this year first given in a tabulated form, and the remarks upon the same separately. They are divided, as in previous years, under the different headings of *Song*, *Migration*, *Nesting*, and, from the number of observations sent in, have been strictly confined to the list of birds as scheduled in the "Instructions" issued by the Council of the Society.

The Hertfordshire stations, such as are within a comparatively circumscribed area, namely, Hertford, Ware, Hailey Hall, Harpenden, Throcking, Hoddesdon, St. Albans, and Kimpton, are treated as one station, and are represented in the report by *Hertford*.

In each case the average of these eight stations has been taken as denoting the earliest song, arrival, or nesting of birds.

SONG.

80. *Strix aluco* (Brown Owl). Was heard hooting at Sparham on January 2, and again on March 20; the male hooting and female answering. At Hertford (St. Albans) on March 4, and at Harpenden, in the same district, on March 10.

82. *Turdus musicus* (Song Thrush). Taking the average of 15 stations the song of the Thrush was heard for the first time on February 6. In 1880, it was January 29, and in 1879, February 4. This year the earliest stations were Odsey, Belton and Great Cotes, on January 2, 3 and 4 respectively, all stations in eastern districts; latest at Addington, on March 4.

At Bradenham the Thrush was heard singing on December 2, 3 and 4, 1880, and at Cardington from November 1880 to March 1881 whenever the thermometer rose above 40°. At Great Cotes, in 1881, the Thrush was singing up to the middle of December. In Lincolnshire the Thrush has suffered greatly by the severity of recent winters; in the parish of Great Cotes, 2,600 acres, I have this year only known of one pair; and the observer at Belton, Miss F. H. Woolward, remarks, "In this neighbourhood, where last year there were scores, it is quite a rare thing to see or hear one at all." It will be years before the Thrushes in our Eastern Counties recover their former numbers.

84. *Daulias luscinia* (Nightingale). At fifteen stations (excluding Harpenden, in Hertfordshire) the first song of the Nightingale was heard on April 23. In 1880 it was April 21, and in 1879, April 27. It is reported as heard at Harpenden on March 16, or 38 days earlier than the average of fifteen stations. The observer, Mr. T. J. Willis, says, "This is unusually early for the Nightingale, and, being in some doubt about the matter, I mentioned the fact to Mr. Brown, of Laburnum Cottage, Harpenden, and he said there was no mistake, for he had himself heard it every night for a week close to his own house. However, since this week of March 16 it has not been heard again."

Was first heard at the south-eastern stations and gradually extending westward and northward as in previous years. The latest dates are Great Cotes and Hatton, Lincolnshire, both on May 5.

86. *Phylloscopus trochilus* (Willow Wren). The average date of the first song was April 8, against April 14 in 1880, and about April 19 in 1879. Earliest date, Downside (Bath), March 12; latest at Great Cotes, April 16. The Willow Wren arrives very regularly each year about the second week in April, rarely varying more than a few days; the song is not always heard on its first arrival, much depending on the state of the weather and temperature.

87. *Phylloscopus collybita* (Chiff-Chaff). The monotonous note, song it can hardly be called, of the Chiff-Chaff was heard at ten stations on the average of about March 24. The earliest was Sparham, on March 15; latest at

Cardington and Maker, on April 10 and 12. About four days later than in 1880.

88. *Alauda arvensis* (Skylark). Taking the average of 17 stations the Lark was heard singing first on February 20; in 1880, it was January 20; 1879, February 10; and in 1878, January 20; showing a large variation from year to year, and undoubtedly dependent on the prevailing temperature of each special season. Was this year much earlier in the eastern than the western stations.

At Hatton, in 1880, was last heard on November 14; in 1879, at the same station, on November 18.

89. *Fringilla cœlebs* (Chaffinch). Average date of first song was on February 20. The same day the Lark commenced singing, the same causes probably inducing both these species to burst into song simultaneously. Earliest date, Totnes, February 2. Latest at Addington, on March 10. Miss F. H. Woolward (Belton) says, "The number of Chaffinches here this year is unusually large; hundreds are to be seen about the end of March, and nests are now (May 24) very numerous."

91. *Cuculus canorus* (Cuckoo). The average date of the first call of the Cuckoo is April 21, at 26 stations. In 1880, also April 21; 1879, April 19; 1878, April 18. Earliest at Hertford, April 4. Latest at Geldeston* and Sparham, April 30, and May 1; and Colwyn Bay, May 1. Except these latter all the occurrences are in April, verifying the old adage, "in April come he will." The state of the weather and temperature appear to have little to do with the appearance of the Cuckoo.

94. *Columba Turtur* (Turtle Dove). Average time of arrival April 30, which is much earlier than in the preceding year.

MIGRATION.

81. *Muscicapa grisola* (Fly-Catcher). The average time of arrival of this, one of the latest of our summer immigrants, was May 18; in 1880, May 24; and in 1879, May 19. Very susceptible to sudden changes in the weather and temperature; is latest in arrival in cold backward springs.

83. *Turdus pilaris* (Fieldfare). There are not sufficient data from which any reliable deductions can be drawn. In 1880 Fieldfares were seen at Farley first on November 24, and at Hatton, Lincolnshire, on November 30. On the east coast of England, in the autumn of 1880, Fieldfares were seen on their migration first near Norwich, on September 9, and last at Teesmouth (Durham), November 27; the immigration covering eighty days.

85. *Saxicola Œnanthe* (Wheatear). April 11, a very late average, but not later than the observations on migration on the east coast of England show in the spring of 1881.

92. *Hirundo rustica* (Swallow). The average of 28 stations shows the Swallow to have arrived on April 17, against April 19 in 1880, and April 18 in 1879. The earliest stations this year are Hertford, on April 8; Bradenham,

* Was seen at Sparham on April 25.

Station.	Brown Owl. 80.	Song Thrush. 82.	Nightingale. 84.	Willow Wren. 86.	Chiff-chaff. 87.	Skylark. 88	Chaffinch. 89.	Cuckoo. 91	Turtle Dove. 94.	Flycatcher. 81.	Fieldfare 83	Wheatear. 85.	Swallow. 92	Swift. 93.	Woodcock. 96.	Thrush. 82.	Rook. 90.
Maker	..	46	..	..	102	..	..	..	..	..	..	..	103	142	..	....	....
Bridgetown	..	31	..	..	76	92	33	118	..	..	..	..	103	121	..	....	60. Building
Babbacombe	..	..	..	..	..	..	..	105	112	..	..	..	116	145	..	....	....
Trusham	..	..	..	..	..	..	..	120	..	..	..	..	..	..	..	....	....
Yeovil	..	..	..	..	..	..	..	106	..	..	..	..	108	..	..	....	....
Salisbury	..	..	..	..	..	41	..	106	..	141	..	..	108	121	..	....	59. "Beginning to build"
Downside	..	37	..	71	..	47	..	..	..	135	71	..	..	125	..	....	69. Building
Marlborough	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	....	38. Building
Strathfield Turgiss	..	..	104	..	..	..	..	106	..	..	..	..	106	140	..	104. Young	....
Isleworth	..	..	105	..	..	38	..	108	..	..	..	..	104	135	..	80. Nest and eggs	....
Lewisham	..	..	..	..	..	34	..	..	..	..	..	..	..	..	..	....	....
English Bicknor	..	..	..	..	..	..	..	108	..	..	..	..	110	..	..	....	....
Bradenham	..	..	121	101	79	..	..	112	124	127	..	..	98	123	..	....	....
Watford	..	41	105	..	..	..	..	105	..	..	..	..	..	..	..	....	61. Building
Berkampstead	..	..	..	..	..	..	..	..	..	..	..	..	..	127	..	....	....
*Hertford	63	44	105†	104	75	33 & 37	55	94	..	..	..	..	93	127	..	....	59. Building
Malvern	..	33	119	..	88	68	..	108	114	..	..	94, 84‖	110	..	..	....	....
Addington	..	63	106	..	..	63	69	107	..	..	..	..	108	..	..	81. Sitting	53. Building
Bocking	..	..	118	..	..	48	..	119	..	..	..	..	..	..	..	....	....
Cardington	..	..	106	..	100	..	..	106	..	..	..	..	107	..	..	....	....
Silsoe	..	..	..	..	..	..	..	104	..	..	..	..	112	..	..	....	....
Odsey	..	2	103	..	..	31	..	110	122	129	..	88	113	136	..	{ 73. Nests and eggs { 104. Hatched	56. Building
Great Hormead	..	57	..	..	..	48	34	..	..	..	..	..	..	..	..	....	56. Building
Sedgeley	..	..	..	..	76	..	..	..	..	..	..	..	..	..	..	....	....
Uppingham	..	57	..	..	..	46	53	119	..	..	..	..	105	..	..	....	....
Geldeston	..	..	106	..	76	..	..	120	..	..	..	..	115	..	..	....	..
Burton-on-Trent	..	..	..	..	..	..	57	..	..	..	..	..	..	..	..	....	..
Belton	..	3	116	..	..	..	..	118	..	138	..	..	107	123	..	....	....
Sparham	2 & 79	42	115	101	74	47	44	121	..	128	..	..	103	..	..	98. About a week old	69. Building
Chester	..	56	..	101	78‡	70	57, 69§	121	127	..	..	123¶	112	..	..	105. Able to fly	68. Building
Farley	..	..	..	..	..	..	..	108	..	..	..	..	..	..	..	....	....
Hatton	..	..	125	102	..	..	47	117	..	..	..	..	106	126	..	112. Sitting	48. "Inspecting" nests
Parbold	..	..	..	..	..	65	..	117	..	..	..	..	101	..	..	....	....
Great Cotes	..	4	125	106	..	48	..	116	..	137	..	115	105	140	Sept. 8	....	61. Building
Durham	..	..	..	..	..	..	..	..	..	..	..	..	..	135	..	....	....
Waterford	..	34	..	..	..	..	40	..	..	..	34	..	..	..	..	....	54. Just ready for eggs
Average	..	37	113	98	83	51	51	111	120	133	..	101	107	131	..	....	58

* Including Eight Stations. † At Harpenden reported March 16th. ‡ Alyn Valley, Mold. § Baguilt, North Wales, 69. ‖ Malvern Hills. ¶ Carnedd Llewelyn, N. Wales, 2,000 feet above sea.

April 8; and Babbacombe, Devon (now for the fourth year), the latest, April 26.

Swallows and Martins have been observed during the past autumn on the south-eastern and southern coasts of England, in certain localities, quite up to the end of November.

93. *Cypselus apus* (Swift). Average time of arrival at 15 stations May 11, against May 16 in 1880, and May 11 in 1879.

Earliest at Bridgetown (Totnes), on May 1, and the same day at Salisbury. Wiltshire has made the earliest returns for the Swift for the last four years.

96. *Scolopax rusticola* (Woodcock). First seen at Great Cotes, on September 8, a pair, fresh in from the sea. Since this time have come across very irregularly, as noted at various stations on the east coast, quite up to the end of November, and not in those great flights or "rushes" which are characteristic of their ordinary immigration.

NESTING.

82. *Turdus musicus* (Song Thrush). Not sufficient data for any reliable deductions; it may be taken for granted, however, that in the earliest and mildest springs the date of the Thrush's nesting will always be earlier than in opposite seasons and low temperature.

95. *Perdix cinerea* (Partridge). The observations under this species show very variable results, and no conclusions can be drawn. In North Lincolnshire I have observed that the state of the weather has everything to do with the pairing of the partridges. In fine open winters they are paired before the close of the shooting season, and in opposite seasons will remain in coveys till the end of February and later.

DISCUSSION.

MR. MAWLEY said that he did not know of any other British plant on which the cumulative effects of recent winters could be so plainly traced this year as the common Bramble (*Rubus fruticosus*). His attention had been directed to this plant early in spring, and since then he had taken particular care to notice the appearance of the Blackberry bushes in the hedges and elsewhere wherever he went, and in almost every instance had found a large number of dead stems, and a very small proportion of live ones, and these generally of but feeble growth. In some cases many of the plants had been killed outright. Even in sheltered spots on the south coast, and in the Isle of Wight itself, he had here and there come across plants which had been very severely crippled. The large amount of injury thus shown was not, he considered, due to the severity of the winters alone, but to the backward summers and cold autumns as well, which had of late so frequently preceded them, and thus contributed their share by preventing the perfect ripening of the new growths. This would be better understood when he stated that it was the habit of the Bramble to throw up strong shoots from the base, which became matured and bore leaves one year and flowers and fruit the next, and that it is invariably the best ripened stems which in times of extreme cold are the least injured. It was, therefore, no wonder that after these unfavourable conditions had been three times repeated, there should, even in an autumn when all other berries were so surprisingly abundant, be comparatively few Blackberries. Indeed, if the seasons were to continue equally unfavourable for a few more years, he doubted much whether at the end of that time there would be many Blackberry bushes left in the country.

PROCEEDINGS AT THE MEETINGS OF THE SOCIETY.

November 16th, 1881.

Ordinary Meeting.

George James Symons, F.R.S., President, in the Chair.

James Aitken, J.P., Union Bank of Scotland, Braemar, N.B.;
Thomas Armstrong, F.R.M.S., Highfield Bank, Urmston, near Manchester;
J. Spencer Balfour, M.P., Wellesley House, Croydon;
Surgeon-Major William Black, F.R.C.S.E., 2 George Square, Edinburgh;
Samuel Richard Bosanquet, J.P., Dingestow Court, Monmouth;
Lieut.-Col. Lewis Mansergh Buchanan, Edenfel, Omagh, Co. Tyrone;
Henry Davey, M.Inst.C.E., Rupert Lodge, Grove Road, Headingley, Leeds;
William Henry Dines, B.A., Corpus Christi College, Cambridge;
Thomas Farmer, 301 Smithdown Road, Liverpool;
Sergeant Alexander Fraser, Roy Bridge, Inverness-shire;
Rev. Edwin Hammonds, St. John's College, Battersea, S.W.;
John Hill, M.Inst.C.E., Ennis, Co. Clare;
Richard Nicholas Howard, J.P., Greenhill House, Weymouth;
Thomas Kilham, F.R.G.S., Newton House, Tunbridge Wells;
John Rickman Knight, 54 Stanhope Gardens, Queen's Gate, S.W.;
Sampson Low, Junr., B.A., 4 Great James Street, Bedford Row, W.C.;
Henry Bean Mackeson, F.G.S., Hillside House, Hythe;
Alexander Stewart Malcolm, Tromode, Isle of Man;
Arthur William Moore, M.A., J.P., Cronkbourne, Douglas, Isle of Man;
Prof. Hugo Ohm, B.A., Royal Agricultural College, Cirencester;
Rev. John Power, Altarnum Vicarage, Launceston;
Henry Saxon Snell, F.R.I.B.A., 22 Southampton Buildings, W.C.;
Charles Upton Tripp, M.A., Grammar School, Burton-on-Trent;
Edward Tucker, Junr., Woodlands, Elterwater, Ambleside;
Jonah Watkins, The Bank, Llandovery;
Rev. Edward Wells, B.A., Flamstead Vicarage, Dunstable; and
Benjamin Ingham Whitaker, J.P., Hesley Hall, Bawtry,
were balloted for and duly elected Fellows of the Society.

The following Papers were read:—

"On the Gale which passed across the British Isles, October 13th-14th, 1881." By G. J. Symons, F.R.S., President. (p. 1.)

"History of the Gale of October 13th and 14th, 1881, over the Atlantic Ocean, and on the Coasts of the United Kingdom." By Charles Harding, F.M.S. (p. 17.)

"On the Structural Damage caused by the Gale as indicative of Wind Force." By J. Wallace Peggs, Assoc.M.Inst.C.E., F.M.S. (p. 29.)

"On the Meteorology of Mozufferpore, Tirhoot, 1880." By C. N. Pearson, F.M.S. (p. 40.)

December 21st, 1881.

Ordinary Meeting.

George James Symons, F.R.S., President, in the Chair.

Herbert P. Bell, Royal Alfred Observatory, Mauritius;
Frederic Bernard Edmonds, 72 Portsdown Road, W.;

THOMAS CAMERON EVANS, Exchequer & Audit Dept., Somerset House, W.C.;
SAMUEL L. FOX, 924 Chestnut Street, Philadelphia, U.S.A.;
JOHN JAMES GILBERT, 72 Cambridge Street, The Crescent, Birmingham;
MATTHEW HENRY, Warwick Villa, Blackheath Rise, Lewisham, S.E.;
JAMES BRADDON MCCALLUM, Borough Hall, Stafford;
JOSEPH PARRY, Municipal Offices, Liverpool; and
BEAUCHAMP CHARLES WAINWRIGHT, Elmhurst, East End, Finchley,
were balloted for and duly elected Fellows of the Society.

Mr. J. S. DYASON and Mr. C. HARDING were appointed Auditors of the Society's Accounts.

The following Papers were read:—

"THE RAINFALL OF CHERRAPUNJI, ASSAM." By Prof. JOHN ELIOT, M.A., F.M.S. (p. 41.)

"ON THE METEOROLOGY OF CANNES, FRANCE." By WILLIAM MARCET, M.D., F.R.S., F.M.S. (p. 59.)

"REPORT ON THE PHENOLOGICAL OBSERVATIONS FOR 1881." By the Rev. T. A. PRESTON, M.A., F.M.S. (p. 73.)

RECENT PUBLICATIONS.

AMERICAN JOURNAL OF SCIENCE. Vol. XXIII. January 1882. 8vo.

Contains:—Contributions to Meteorology: being results derived from an examination of the observations of the United States Signal Service, and from other sources. By E. Loomis. Sixteenth Paper (24 pp.). This paper is devoted to the mean annual rainfall for different countries of the globe, and gives a table of the annual fall at 713 stations. The author believes the following are the principal causes of excessive rainfall:—1. The meeting of the NE and SE Trade Winds, resulting in a great rain-belt surrounding the globe; 2. The irregular barometric depressions of the middle latitudes; 3. Mountain ranges causing increased rainfall on the side from which the prevalent wind proceeds; 4. Proximity to the ocean, especially when the prevalent wind comes from the ocean; and 5. Capes and headlands, projecting considerably into the ocean, generally receive a greater rainfall than neighbouring districts. The following are some of the causes of deficient rainfall:—1. A nearly uniform direction of the winds throughout the year, such as prevails within a portion of the system of the Trade Winds, especially in mid-ocean, and to some extentover the continents; 2. The prevalent wind, having passed over a range of elevated mountains, descends upon the leeward side; 3. Ranges of mountains so situated as to obstruct the free movement of the surface winds toward a central region; 4. Remoteness from the ocean measured in the direction from which the prevalent wind proceeds; and 5. High latitude. Prof. Loomis appends a map showing the distribution of mean annual rainfall over the greater part of the globe.

ANNALI DELLA METEOROLOGIA. Parte I. 4to. 1881.

Contains:—Andamento diurno e annuale della Stato del Cielo, del Prof. D. Ragona (28 pp. and one plate.) This is a discussion of the daily and annual amount of cloud at Modena during the period 1865-80.

ANNUAIRE DE LA SOCIÉTÉ MÉTÉOROLOGIQUE DE FRANCE. 29me Année, 1881. 1er Trimestre. Second fascicule. 4to. 1881.

Contains:—Observations météorologiques faites au Sahare en janvier, février, mars et avril 1880, par M. G. Rolland (18 pp.)—Notice sur le climat du Gabon, par Dr. A. Borius (9 pp.)—Le magnétisme et ses rapports avec la prevision du temps, par M. Descroix (3 pp.)

Annual Report of the Royal Alfred Observatory, Mauritius, for the Year 1880. By C. Meldrum, LL.D., F.R.S., Director. 89 pp. Folio. 1881.

A 'persistent deficit in the rainfall' is noticed as a distinctive and important feature of the weather of the year. It appears that the rains showed a decrease of 34 per cent. as compared with the average of the preceding ten years; but it is presumed that this may be chiefly ascribed to the absence of hurricanes and storms from this part of the Indian Ocean, rather than to any cause connected with the island itself. Dr. Meldrum makes some valuable remarks on the relation of the rainfall to fever mortality and sugar cultivation.

Brief Sketch of the Meteorology of the Bombay Presidency in 1880. By F. Chambers, Meteorological Reporter for Western India. 4to. 19 pp. and 8 plates. 1881.

The meteorology of the year 1880 was characterised by several strongly marked deviations from the climatic conditions of an average year. Of these the most noteworthy were, a general rise of abnormal barometric pressure from the earlier to the later months of the year, an abrupt and unusually early commencement of the hot season, a general deficiency of rain in August, and a large excess in September. These variations of the rainfall were in general accordance with the usual rule that the rainfall is deficient when the barometer is above the normal height, excessive when the barometric reading is lower than usual; and they thus confirm the conclusions drawn from the observations of previous years. The closeness with which this rule (in connection with others) is observed, not only with regard to the total rainfall of a month, but also with regard to the general rainfall of a district on individual days, and the practicability of obtaining such telegraphic information from distant stations as will enable the character of impending barometric movements to be foreseen, holds out a hope that the time is not far distant when it will be possible to frame daily and monthly forecasts of the general character of the coming rainfall.

Cape of Good Hope. Report of the Meteorological Commission for the Year 1880. Presented to both Houses of Parliament by Command of His Excellency the Governor. 1881. 85 pp. Folio.

This report contains the results of the meteorological observations made under the direction of the commission at 24 stations; and rainfall returns from 118 stations. In December 1879 the Secretary started on a tour of inspection; and the results of his examination are given in the Report.

Eighth Annual Report of the Secretary of the State Board of Health of the State of Michigan, for the Fiscal Year ending September 30, 1880. 596 pp. 4to. 1881.

Among other papers this contains:—Air-moistening, by J. K. Allen (3 pp.).—Ozone in Nature, its Relations and Influences, by John Mulvany, M.D. (6 pp.).—Relative to Atmospheric Ozone, and the best methods for its observation, by A. W. Nicholson, M D. (16 pp.).—The principal Meteorological Conditions in Michigan during the year 1879 (60 pp.).

Lightning Rod Conference. Report of the Delegates from the following Societies, viz.:—Meteorological Society, Royal Institute of British Architects, Society of Telegraph Engineers and of Electricians, and Physical Society. With a Code of Rules for the erection of Lightning Conductors; and various Appendices. Edited by the Secretary, G. J. Symons, F.R.S. 290 pp. 8vo. 1882.

The Report consists only of 19 pages, and is divided into three sections, viz. 1. The purpose which a lightning conductor is intended to serve; 2. A statement of those features in the construction and erection of lightning conductors respecting which there has been, or is, a difference of opinion, and the final decision of the conference thereupon; 3. Code of rules for the erection of lightning conductors. There are 13 Appendices to the Report, the two most important of which contain abstracts of sixty separate treatises (91 pp.); and a catalogue of

works upon lightning conductors, with a few upon lightning, thunder, and the effects of lightning stroke (32 pp.).

MEMORIE DELLA R. ACCADEMIA DI SCIENZE, LETTERE ED ARTI DI MODENA. SEZIONE DI SCIENZE. Vol. I. Ser. II. 4to. 1881.

Contains:—Andamento diurno e annuale della Evaporazione, del Prof. D. Ragona (28 pp.). This is a discussion of the daily and annual amount of Evaporation at Modena.

NORDISK TIDSKRIFT. 1881. 8vo.

This contains a valuable contribution to meteorological bibliography, viz. Index to the Meteorological Publications from Sweden, 1856-1881, by C. G. Fineman. (6 pp.).

QUARTERLY WEATHER REPORT OF THE METEOROLOGICAL OFFICE. (New Series.) Published by the Authority of the Meteorological Council. Part I. January—March 1876. 77 pp. and 58 plates. 4to. 1881.

The issue of the Quarterly Weather Report has been resumed in an improved form. The Report is divided into three sections, viz.:—1. A general summary or statement of the chief features of the weather for the whole quarter; 2. A table of the principal cyclonic and anticyclonic systems; 3. Remarks on the distribution of wind, pressure, temperature, vapour, and rainfall for each month, accompanied by plates showing the relative prevalence of wind from each of eight points, the distribution of mean pressure, the movements of the depressions referred to in section 2, the distribution of mean temperature, and the amount of rainfall measured at each station. The Report is illustrated by two sets of plates, (1) Chart plates, showing by small maps the distribution of pressure and the winds prevailing at 8 a.m. and 6 p.m. daily; and (2) the usual plates giving on a reduced scale the curves of the self-recording instruments at the seven observatories, in the same way as in previous Reports.

There are also three Appendices, viz. I. Mean monthly results for the seven observatories for 1876.—II. Report on the reduction of the Greenwich records for 1875 to a common standard with those of Kew, by R. H. Scott, F.R.S. This inquiry shows that such a comparison of minute differences as that originally contemplated by the Meteorological Council cannot be effectually carried out unless the methods employed at the two stations are the same, and the instruments precisely similar. At the same time the comparison has afforded satisfactory evidence of the great general accordance of the records at the two stations in their main features.—III. On the results of observations made at the Pagoda, Royal Gardens, Kew, and elsewhere, to determine the influence of height on thermometric readings, on vapour tension, and on humidity, by R. H. Scott, F.R.S.

REGENWAARNEMINGEN IN NEDERLANDSCH-INDIË. Tweede Jaargang 1880 door Dr. P. A. BERGSMA. 291 pp. 8vo. 1881.

This gives the daily, monthly, and yearly rainfall at 125 stations in the East Indian Archipelago for the year 1880. The value of this work is greatly enhanced by containing a short account of the position, &c. of each station. The stations in operation on January 1st, 1881, were distributed on the different islands of the Archipelago as follows:—Java, 76; Madoera, 3; Sumatra, 25; Riouw, 1; Bangka, 1; Billiton, 4; Borneo, 8; Celebes, 4; Ternate, 1; Amboina, 1; Banda, 1; and Timor, 1.

SYMONS'S MONTHLY METEOROLOGICAL MAGAZINE. November 1881 to January 1882. Nos. 190-192. 8vo.

Among other articles are the following:—The organisation of the meteorological service in some of the principal countries of Europe—Great Britain, by Dr. Hellman.—Effects of a supposed "Waterspout" on Little Haldon, South Devon, on 21st October, 1881, by G. W. Ormerod.—A plea for the Rainband, by J. R. Capron.—Le Verrier as a Meteorologist, by J. S. Harding.—Reorganisation of the Meteorological Department of India.

THE FORTY-EIGHTH ANNUAL REPORT OF THE ROYAL CORNWALL POLYTECHNIC SOCIETY, 1880. 8vo. 1881.

Contains two meteorological papers, both by Mr. Wilson L. Fox, viz. (1.) The Sunshine Recorder (5 pp.); and (2.) Notes on the Meteorology of Falmouth for the year 1880 (11 pp.).

THE ROSARIAN'S YEAR BOOK, 1882. 8vo. 99 pp.

This contains a paper by Mr. E. Mawley entitled 'The Weather of the past Rose-Year' (20 pp.).

THE "TIMES" REGISTER OF EVENTS IN 1881. 215 pp. 8vo. 1882.

In addition to other valuable information for the year 1881, this work contains the daily Weather Charts and Reports for 8 a.m., Weekly Diagrams and Reports of the Kew Observatory for each week, and summaries of the weather with charts for each month.

TRANSACTIONS AND PROCEEDINGS OF THE ROYAL SOCIETY OF VICTORIA. Vol. XVII. 8vo. 1881.

Contains:—On some curious effects of Lightning at Gabo Island, by A. Lilly (2 pp.).—An improved Ombrograph, or self-registering Rain-Gauge, by R. L. J. Ellery, F.R.S. (4 pp.).

ZEITSCHRIFT DER OESTERREICHISCHEN GESELLSCHAFT FÜR METEOROLOGIE. Redigirt von Dr. J. HANN. XVI.-XVII. Bande. November 1881-January 1882. 8vo.

Contains:—Ueber die Durchsichtigkeit der Luft in Upsala, von Dr. H. E. Hamberg (5 pp.).—Einige Bemerkungen zur Frage über eine directere Nutzbarmachung der meteorologischen Beobachtungen für die Bodencultur, von Dr. J. Hann (7 pp.).—Der hydrostatische Barograph, von Dr. P. Schreiber (14 pp.).—Die Niederschläge zu Ende August und Anfang September 1881 in der Schweiz und ihre Beziehung zur Vertheilung des Luftdruckes, von R. Billwiller (5 pp.).—Noch einige Bemerkungen zur Frage über eine directe Nutzbarmachung der meteorologischen Beobachtungen für die Bodencultur, von F. G. Friesenhof (5 pp.).

QUARTERLY JOURNAL

OF

THE METEOROLOGICAL SOCIETY.

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ON THE PRESENT STATE AND FUTURE PROSPECTS OF METEOROLOGY. AN ADDRESS DELIVERED BY THE PRESIDENT, G. J. SYMONS, F.R.S., AT THE ANNUAL GENERAL MEETING, JANUARY 18TH, 1882.

I AM sure that it is an extremely wise rule of the majority of Societies, that the President's tenure of office be limited to two years. The period is sufficiently long for the President to become familiar with the duties, and able to apply judiciously such knowledge as he may possess, and yet it is not long enough for his zeal in the work to flag, or for him to lose the consciousness of the responsibility which attaches to the office. Moreover, by the tenure being limited to two years many of the Fellows successively pass the chair, and thus the Society has the advantage of obtaining and placing on record their various views. And doubtless my predecessors have felt as I do, in rising for the last time, that it is a somewhat solemn occasion; it is but once in his life that any man can submit his last Presidential address to this Society, and whether it be wise or imprudent it will stand to all time, a silent, yet ever living, testimony for or against its author.

Holding these views, I at once abandon all attempt at writing a methodical address, and purpose devoting my time to that which I believe to be most necessary, viz. the consideration of the present state and future prospects of meteorology. I know that this subject has been treated of by many of my predecessors, but it can hardly be too often brought before us, and it presents itself differently to every mind. In fact, as every President has to give two addresses, it might be well to make it an unwritten law that the second address of every President should express his views on the present state and future prospects of meteorology.

It is impossible to make such a survey as I desire either complete, systematic, or harmonious; it seems to me that it must be fragmentary, and

hence necessarily lack cohesion, and remain a mere collection of criticisms and suggestions. Criticisms and suggestions, be it remembered, for which the author alone is responsible, and with which few may agree.

Our present system of observation first presents itself for consideration—in what respects is it capable of improvement? Should it be extended either as regards distribution of stations, additional instruments, or additional hours of observation? Can any of the millions of entries at present made annually be dispensed with? These questions can only be properly answered after considering two others. What observations are being made? and for what object? From the earliest times it has been usual to give the place of honour in the observation-book to the record of barometric pressure, and therefore I will take it first. As regards the instruments, I do not think that we need press for many improvements. For observatories of the first order the Kew pattern photographically recording barograph, duly checked by eye observations, is perfect, and of such instruments I think that ten well distributed over the British Isles would be ample. There are already seven at the observatories of the Meteorological Council (Falmouth, Kew, Valencia, Stonyhurst, Armagh, Glasgow, and Aberdeen), and efficient instruments carefully worked at Greenwich and Oxford. If the cost of another is prohibitory, it would, I think, be wise to send the Kew one to the Orkney or Shetland Isles, for we do not require three out of the ten instruments in the 57 miles between Oxford and Greenwich. For second order stations, where the barometer is recorded twice daily, it is not easy to decide what is the best pattern of instrument. Fortin's pattern has both advantages and defects; among the former is the fact that the loss of a little mercury does not at all prejudice its indications, because as long as the vacuum is perfect and there is mercury enough to fill the cistern up to the ivory point the reading must be correct. The disadvantages are the oxidation of the mercury in the cistern, and the fact that all but careful observers make inaccurate adjustment of the mercury to the ivory point. The Kew pattern, while it has not this source of error, has another in that there is no means whereby the observer can be sure that it indicates correctly; if the wooden cistern leaks and mercury escapes into the metal case the barometer reading will be too low, but the observer may remain ignorant of the fact.

A more serious question than that of the pattern of the instrument is that of the number of observations. Occasionally, when tracing a storm, it is extremely advantageous to have the records of perhaps 100 or 150 standard barometers in the British Isles, but on all ordinary occasions I fear that ten times as many barometer readings are recorded as can ever be utilised. Take my own case. I began recording the pressure in the north of London twice daily in 1858, and for the whole subsequent period have continued the practice; that gives about 17,000 readings. Who will ever work up those observations? And if that imaginary Newton, who is to utilise all the millions of observations which are yearly being added to the store, ever does arise, is it probable that my figures will yield results differing for any

practical purpose from those already obtained for Greenwich, or from those worked up by Mr. Eaton?

The proximity of stations should primarily be regulated by the variability or otherwise of the element to be observed. For instance, for determining monthly and annual isobars one station in each 1,000 square miles would probably be sufficient, but for climatological purposes, in which we have to study local characteristics, we should need, in Brighton, for example, at least two if not three stations, and for engineering purposes in all parts of the country we can scarcely have rain-gauge stations too close.

With reference both to second order and to climatological stations, there are several grounds upon which the maintenance of numbers of stations in excess of all apparent requirements can be justified. The chief is the constant difficulty which arises from the removals and deaths of the observers, and from the extension of buildings, the growth of trees, &c. This renders it necessary to have two or three stations wherever we desire to make sure of a continuous record. But a far better and more scientific plan would be to choose a few unexceptionable localities remote from towns, to purchase the freehold of a few surrounding acres, erect thereon stations identical in every respect, and endow them with moderate funds, so that humanly speaking the observations may be established on a perpetual and unalterable basis. Some persons may think that I have forgotten the seven observatories of the Meteorological Council, and that they fulfil the above requirements. Those observatories have doubtless yielded valuable information, but they hardly fulfil one of my conditions. Some are in the open country, some in the heart of towns, few are in the centre of freehold land, the buildings are by no means uniform, and instead of possessing endowments they all depend on that shifting sand—a parliamentary vote. Other persons may say that the scheme is Utopian. I do not think so. Mr. Gassiot gave £10,000 to endow Kew, and looking at the enormous sums now waiting for worthy objects, looking at such gifts as that of Sir Josiah Mason, and many others, I see no reason why some like-minded man should not resolve upon so building and endowing half a dozen first order Meteorological Observatories, that they may go on without modification for centuries. That would be the way to study secular changes.

For climatic purposes I think that the numerous Climatological Stations started by this Society are of great value—especially considering the rigorous examination to which the records are subjected. But in mentioning these stations attention is immediately drawn to one of the principal items which we want them to teach us, viz. the relative dampness of the various health resorts; a subject which is in an extreme state of uncertainty. In this country we use almost exclusively the dry and wet bulb thermometer, and Glaisher's tables for working out the results. I do not sufficiently understand the subject to express any opinion as to what values are true and what are false, but I will give one or two illustrations and references, and leave it to the Fellows to say whether it is not a mockery to publish any *deductions* while such wild discrepancies exist. I hope that either the experiments now

going on at Cambridge, or some others, may show us how retrospectively to utilise our records of dry and wet bulb temperature, and had I not that hope I should seriously consider whether it was worth while to print even the readings of the wet bulb thermometer.

As regards high temperatures I will quote a short table given by Mr. F. Chambers in his Administration Report for Bombay for 1875-6. The observations were made at Deesa.

Date.		Barometric Pressure.	Dry Bulb.	Wet Bulb.	Dew-Point.			
					Calculated by			Observed by Regnault's Hygrometer.
April 1876.	Hour.				Glaisher's Factors.	Apjohn's Formula.	August's Formula.	
		ins.	°	°	°	°	°	°
24	9·30 a.m.	29·297	93·2	63·0	44·7	39·3	31·5	22·5
	3·30 p.m.	29·207	102·5	65·6	44·9	37·2	26·6	12·7
25	9·30 a.m.	29·327	92·6	62·7	44·3	40·0	31·2	23·3
	3·30 p.m.	29·218	104·4	69·5	50·3	47·9	40·8	23·2
26	9·30 a.m.	29·296	91·7	67·0	51·7	51·9	48·0	45·0
	3·30 p.m.	29·194	105·1	71·5	53·0	52·8	47·3	35·1

I of course by no means maintain the accuracy of these observations, but as regards columns 6, 7 and 8 the differences are due to the formulæ, and, therefore, the question as to the accuracy of the observations does not arise. Besides, these discrepancies are well known, and those interested in studying their amount can do so in Guyot's *Tables* or in Williamson "*On the use of the Barometer.*" There is also the startling table of Factors given by Lieut. Noble, R.N., in the *Proc. Roy. Soc.* 1855, and if last not perhaps least are the remarkably discordant values of the Dew Point given by calculation from the dry and wet bulb thermometer and observed by Dines's hygrometer. All this evidence forces me to the conclusion that, until the tables for deducing hygrometrical results from the readings of the dry and wet bulb thermometer have been thoroughly rehabilitated, it is of doubtful expediency to spend either time or money in the calculation and discussion of the results.

As regards wind. Our anemometers require thorough consideration in several respects. The pressure ones give indications which architects, engineers, and builders seem to agree in stating would overthrow the majority of our lofty chimneys. Dr. Dohrandt, Dr. Robinson, and Prof. Stokes seem agreed that the old assumption that the cups of the velocity anemometer always travel at one-third of the speed of the wind is wrong, and yet I have not heard of any efforts towards making these instruments record values which are nearer to the truth. I do not think that I am unduly anticipating Mr. Rogers Field, M.Inst.C.E., in stating that the elaborate experiments which during the past two or three years he has been making on behalf of the Cowl committee of the Sanitary Institute of Great Britain, will show that extreme uncertainty attaches also to all observations made with the small air meters. Moreover, all three patterns are alike open

to the criticism that they are designed to indicate the effect of horizontal currents, while we know perfectly well that air currents are rarely parallel to the earth's surface.

Besides the sources of uncertainty mentioned above there is another still greater, that due to the utter anarchy which prevails in the mode of erecting the instruments. It is self-evident that the velocity of the wind varies according to the nature of the surface over which it passes, and moreover, that with identical physical configurations the velocity will be different at different heights above the earth. The least acquaintance with hydraulic formulæ would prove this, and obviously the effect will be greater and more complicated in the lighter and more mobile air current than in the water one. Every tree and every building sends the air current upwards and downwards, to the right hand and to the left, and yet our anemometers are stuck a few feet only above the roofs of buildings which vary in their orientation, in their style, in their extent, in their height, and in their surroundings, as widely as it is possible to imagine. How can any useful comparisons be made of the results from instruments in circumstances so diverse? I do not know who is to do the work, but the whole question of anemometry is in such a state that an exhaustive examination ought to be at once undertaken. Mr. Thomas Hawksley, F.R.S., and Past President of the Institution of Civil Engineers, concluded a severe criticism upon anemometers which he read before the British Association at York, by suggesting that the various societies interested in the subject should unite in endeavouring to obtain more accurate data. The same idea, but somewhat differently expressed, forms the conclusion of the paper read before this Society by Mr. J. W. Peggs, Assoc.M.Inst. C.E., upon "The Structural Damage caused by the gale of October 13th-14th, 1881, as indicative of Wind Force."

Our records of the lowest temperature to which vegetation is exposed are, I fear, far from satisfactory or comparable. They are unsatisfactory because the Rutherford spirit minimum thermometer is frequently rendered erroneous by the condensation of spirit at the top of the tube, and they are not strictly comparable because the indications depend upon the nature, length, and state of the grass over which the thermometers are placed. I cannot help thinking that comparable results will never be obtained until the use of grass is abandoned.

The observation of the amount of ozone present in the air has during the past ten or fifteen years been almost neglected. I am aware that the ozone papers formerly used were very far from perfect, and that their discolouration did not depend solely, or perhaps even chiefly, upon ozone. But all the records which I have seen, and all the experiments which I have tried, tend to show extreme discolouration at such places as Braemar, Harrogate, Margate, and Ilfracombe, and no discolouration in the heart of London, of Sheffield, or of Newcastle. Between those extremes there must be intervening degrees, and the study of those gradations should surely be forwarded by the observers at our climatological stations.

In Paris extreme care is taken in the examination under the microscope of

the particles composing atmospheric dust; at present we are doing nothing or next to nothing in that direction. As, however, the British Association has appointed a committee to investigate meteoric dust, and it is not obvious how it can carry out those investigations without including atmospheric dust, progress may be reasonably anticipated.

I must, however, pass to a different class of subject, that of deductions as distinguished from that of instruments. First in that list I place Daily Maps of Atlantic Weather on a scale of not less than 1 inch to 300 miles. The compilation of such charts is essentially national or international work, and falls wholly within the domain of the Government office. Years ago Captain Toynbee showed us what could be done. I have long pleaded for their regular issue, and shall continue to do so because, irrespective of their utility as contributions to Physical Geography and to Navigation, they are, I believe, the best helps towards increased accuracy in Weather Forecasting. I am glad to plead this cause in the very words of the Meteorological Council, for when they published Captain Toynbee's charts they said:

"The Meteorological Council have authorised the present publication as a "remainder of the work of their predecessors. It cannot be doubted that "more work of the same nature as that here submitted would throw light on "the atmospherical conditions which influence and determine the weather "in the West of Europe."

Moreover, in thus writing, the Meteorological Council only repeated what Le Verrier had urged a dozen years previously, viz. on January 29th, 1864, when, speaking of the charts in the *Bulletin International*, and pleading for Meteorological Records from the Atlantic, he said:—

"Unfortunately our charts embrace only Europe, which is not sufficient. "They contain nothing of what is occurring on the surface of the ocean, and "this is the more to be regretted since most of the storms which attack us "seem to take their rise in those parts."

On the next subject, far from there being similar unanimity, opinions differ widely, and I have not studied the subject sufficiently to form any opinion at all. The general public, and not a few meteorologists, attach considerable importance to the storm warnings issued by the Weather Bureau of the *New York Herald*. On the other hand, two of my colleagues on the Council, who have studied the subject independently, have become convinced that they are useless. Whatever may be the ultimate verdict, there is one thing that I should like to see rectified. I do not think that Mr. Gordon Bennett has received that amount of recognition which his costly and difficult work deserves. He did not begin by explaining his precise mode of procedure, hence wild stories were invented and believed, and hence the whole system was brought into disrepute. Some years since I had the pleasure of spending several days with the first director of the *New York Herald* Weather Bureau, Mr. J. J. Collins, and I was astonished at the knowledge which he possessed of Atlantic storm tracks, and of the causes which modify them.

While on the subject of weather forecasts, I should like to suggest that it would be much better if the English Meteorological Office would imitate that

of the United States, and make its hours of observation equidistant—7 a.m., 3 p.m., and 11 p.m., or 8 a.m., 4 p.m., and midnight, instead of as at present, 8 a.m., 2 p.m., and 6 p.m., intervals of 6, 4, and 14 hours respectively. As *all* telegraph offices are open till 8 p.m., the latter hour might apparently easily and advantageously be substituted for 6 p.m., and as 17 English, 4 Scotch, and 4 Irish stations are *always* open, the difficulty can hardly lie with the telegraph department.

Hitherto I have been speaking of forecasts applying only to a few days. The mere suggestion of forecasting the general character of a season is at present usually received with something akin to derision. This seems to me a grave mistake. No one can realise the value of such knowledge if it can be obtained, and just as I would thank the *New York Herald* for what it has done and urge it to try and do more, so I would thank every man who is trying to solve the difficult—*possibly* the insoluble—problem of coming seasons. I care not what his system may be: he may hope with Dr. Meldrum and Mr. Norman Lockyer to find in the solar spots the key to the mystery. But, if so, will not that bring us round to the old and now heretical theory of planetary influence? A truly strange result. Yet De La Rue is held to have shown that the sun-spots are influenced by the position of Venus and Mercury; and if meteorological phenomena synchronise with solar spots, they must also synchronise with the positions of the planets. I by no means affirm that any such connection exists, I point out merely the curious result which would follow its establishment.

Our investigator may work at solar phenomena; he may, like the late Mr. Du Boulay, try to forecast the summer from the weather at the vernal equinox, or, like Mr. Brumham, by careful examination of previous sequences or of lunar positions. I care not how he goes to work, but I honour the worker and wish him success.

Leaving forecasts, I come to another serious question, for the examination of which the recently published *Index* to our publications has been most useful. The question may be tersely put thus: Why are 80 per cent. of all the papers published by the Society written by less than 5 per cent. of the Fellows? Years ago Sir George Airy said that "The observing is out of all proportion to the thinking power in meteorology," and the remark is painfully true. There are, I think, two causes which have an important influence in bringing about this result. In the first place, there is a charm about new instruments, and an observation which falls in comfortably with the breakfast hour is rather an amusement than a task; and if the observations are, as is sometimes the case, merely entered on a sheet and not worked out, little inroad is made either on the brains or time of the observer. But it is quite another matter to select a subject, read up what previous authors have written about it, and write a paper upon it yourself. This involves the devotion of considerable time and thought, and in these busy days when the race becomes ever faster and faster there is an increasing tendency to do only those things which pay—not necessarily in money, but in some form or other. At present, of all hopeless courses which a young man who requires to earn his livelihood could

choose, few are so bad as that of a meteorologist. I am revealing no secrets, for I state only what will be found in Blue Books and elsewhere, when I mention, that, irrespective of having to begin with a salary far below that of a bricklayer, the prospective future, after years of exhausting work is a mere nothing. There are not in the whole of the British Isles half-a-dozen meteorological appointments of which the salaries are equal to those of ordinary commercial travellers, and there is no professorship at any college or university. Is it, then, to be wondered at that those who will devote their lives to meteorology are few? Nay, rather does it not redound to the credit of those who have chosen that path of life that, not content with their regular office work, they are among the largest contributors to the pages of our *Quarterly Journal!*

Twelve years have elapsed since Mr. Buchan published the second edition of his *Handy Book of Meteorology*, and matters are rather better now than they were then, but in their broad outlines the statements which he then made as to the absence of meteorology from the ordinary school curriculum are still true, though more book-meteorology is taught now under the new title of physiography than was the case in the byegone days of physical geography. My own views are, however, so well expressed by Mr. Buchan that I gladly quote his words:—

"In the schools of the United States of America, meteorological observa- "tions and the keeping of meteorological registers form a part of the "common education of the people. Also in the higher schools of France "and of some other European countries systematic instruction is communicated "on this subject. But in this country few, even of the liberally educated "classes, are able to read from a vernier; they are ignorant of the use of the "movable cistern of a barometer; they have not the elementary knowledge "to give an intelligible interpretation to the fluctuations of the barometer as "indicative of coming changes of the weather; and when required to "send their barometers to a distance for repair, so ignorant are they of "their construction that they forward them by rail as ordinary parcels, thus "almost to a certainty securing their destruction. This state of things is "the necessary consequence of the general neglect which meteorology receives "in our educational system."

Mr. Buchan then quotes some schools and colleges which are not open to this criticism, and I could double the number; but still I agree with his conclusion, which is:—

"The objects of meteorology can never hold that place in the public mind "to which they are entitled, until the science becomes, as in America, a "recognised branch of education."

We thus see that there is deficient scholastic training, no academical encouragement, and little prospect of those who devote themselves to meteorology obtaining more than a bare livelihood. There are masses of meteorological data awaiting discussion, there is work of all kinds to be done, but, unless there is a material increase in the remuneration at all meteorological establishments, we may be sure that first-class men will hesitate to choose it as their profession instead of the Church, the law, engineering, architecture

or commerce, and meteorology must remain, as it has hitherto done, dependent on the self-denial of its followers. Years ago, when the Meteorological Office was shut up from the afternoon of Saturday to the morning of Monday, I urged that it was impossible to avoid one of two alternatives. Either storm warnings were useful, in which case it was as wrong to stop them on Sunday as it would be to extinguish every lighthouse lamp on Saturday night, or they were useless and therefore should be abandoned entirely. It seems to me that we may argue in the same way respecting meteorology as a whole. Either it is, and is likely to become, or it is not, and is not likely to become, of national utility. If the former, it should be fostered by all reasonable aid; if the latter, the sooner all aid is withdrawn the better. I am quite prepared for criticism hostile to these views, and to see it stated that I have pleaded for endowed idleness, &c. True workers could afford to smile at such remarks, were it not for their possible effect upon those who, while they hold the purse-strings of the nation, must necessarily receive their information on such matters as this at second-hand. But surely it would not be very difficult to devise arrangements whereby remuneration should only follow, and be proportional to, work done.

A few years since there was another cause which tended to check progress. Meteorology consisted then of little beyond the reading of a few comparatively simple instruments, and the calculation and publication of their monthly and annual mean values. Accurate addition and division were the chief essentials for such work, and hence meteorology was regarded as such an extremely easy subject as to be almost beneath notice, and that idea is hardly yet extirpated; those who still entertain it may as well, by way of amusement, make themselves masters of the recent writings of Ferrel, Dohrandt and Stokes. The mention of Prof. Stokes's name leads me to dismiss all attempt at further proof of the different status of meteorology now from that which it held but a few years back, quoting as the sole evidence the tenure of seats on the Meteorological Council by such men as Prof. Stokes and Prof. H. J. S. Smith.

Another obstacle to meteorological progress and a great cause of wasted labour has been the difficulty of ascertaining what has been done in, and what has been written upon, each of the various branches of meteorology. I could give, but I will not weary you, details of many experiments and investigations tried over and over again, each new investigator fancying that it had never been tried before. This is one of the leading arguments in behalf of meteorological bibliography, a subject which has received the approval of nearly all meteorologists, notably at some of the International Congresses, yet towards which little has been contributed except the catalogue of our own library, the value of which has been recognised wherever the subject has been discussed. Our recently published Index will doubtless be accepted as another very useful publication.

It is generally known that Prof. Cleveland Abbe, of Washington, U.S.A., extracted from the splendid *Catalogue of Scientific Papers* published by our Royal Society all the titles of papers bearing upon meteorology. For nearly

twenty years I have myself been forming a bibliography of works upon astronomy, meteorology and terrestrial magnetism, and that catalogue, which now fills 84 volumes, has always been at the disposal of any one who would undertake to complete it and print it. Strong interest in it has often been expressed, but the cost of printing was always regarded as prohibitory, and although I have more than once expressed my desire that our own country should have the credit of doing it, nothing has been proposed, far less arranged.

Life slips away from all of us, and I began to fear lest the bibliography which has cost me considerable labour should be left a mere mass of MS. A few months since, Prof. Abbe wrote for some details respecting the scope of my work, and in my reply I expressed a strong desire to see his catalogue and my own united and published. This letter was I believe laid before the Regents of the Smithsonian Institution; at any rate, mine and one from the Smithsonian Institution were laid before General Hazen, the Chief Signal Officer of the United States, and therefore Director of the Government Meteorological Office, with the result that that Department has undertaken to repay all the expenditure which I may incur for copyists, and the entire cost of editing and printing in America a catalogue embracing every work either in that formed by Prof. Cleveland Abbe or in my own. The execution of my share of the task will involve the gratuitous devotion of many hundred hours to it; but far from begrudging them, I rejoice at the prospect of, as I believe, usefully employing them, and I trust that when all is ended, the United States Government will receive those hearty thanks from all meteorologists which its liberality will, in my opinion, merit.*

It is just possible that the severe manner in which I have criticised a few of our existing arrangements may have led some one to consider that meteorology is languishing, feeble, or even moribund. I believe that the very opposite is the fact; when a case is weak, one hesitates to point out its weakness for fear of a total collapse. No, the Meteorological Society never advanced so rapidly in numbers as it has done in the last few years; and if it will but apply the pruning knife to observations and deductions the utility and trustworthiness of which has not been demonstrated, and try to secure the application of more brain power to the many problems yet unsolved, it will continue to receive an ever-increasing amount of recognition and support, and to maintain that high position among kindred Societies which it at present holds.

REPORT OF THE COUNCIL

FOR THE YEAR 1881.

THE Address delivered by the President at the last annual meeting and printed in the April number of the Quarterly Journal, contained a history

* Hundreds or even a few thousand extra titles would, I am sure, be welcomed by Gen. Hazen, as every one of them would add to the utility of the forthcoming volume.—G. J. Symons.

of English Meteorological Societies from 1823 to 1880, with full details as to the progress of this Society and diagrams showing the number of pages contained in its annual publications, the amount of its invested Capital and the number of Fellows.

Many points however, were necessarily not even alluded to in this interesting address; and as an occasional comparison of the present state of the affairs of the Society with that which obtained in former years is useful, the Council now lay before you a brief notice of these as they now are and as they were in 1871. The chief reason for taking this last-named year as the point of comparison is, that prior to 1872, the Society had continued its work without an office, accessible library, or an Assistant-Secretary; while the staff at present very fully employed, consists of an Assistant-Secretary, and three computers, at an annual cost of about £250. The Society at the former date had no observers of its own, and did not receive any original observations. It was in consequence of the inconvenience arising out of this peculiar arrangement that the Society engaged an office and the services of Mr. Marriott as Assistant-Secretary. In 1871 there were only 314 Fellows on the roll of the Society, and even of these many were considerably in arrear with their subscriptions, for which reason their names were shortly afterwards removed from the list of Fellows; so that in reality the Society was weaker than it seemed to be. In that year the average attendance at the 6 meetings was 25. In 1881, on the other hand, there were 555 Fellows on the roll, and the average attendance with 8 Meetings was 55. The Proceedings were also much smaller in 1871 than our present Quarterly Journal, and contained a considerable proportion of abstracts in the form of an Appendix to the Annual Report. In 1871, the Council decided to print short abstracts of the discussions, which have assisted in making the Journal more interesting and valuable.

The receipts and expenditure in 1871 show a marked contrast to those for the year just past: the receipts amounted to only £244 against more than £840 in 1881. The expenditure was only £197, against about £780 in 1881.

In thus recounting the satisfactory progress of the Society, the Council take the opportunity of pointing out that one of its main objects, aimed at from the first, has been fairly accomplished; namely, the collection of certain thoroughly reliable statistics (though not all that are necessary) for ascertaining the climate of England. Year by year, through the labours of our observers, the series becomes more valuable; and the close scrutiny to which the recorded observations are subjected by the officers of the Society, renders them available for study by theoretical meteorologists. Nevertheless it must be confessed that in this latter aspect, the progress made in the development of the fundamental laws of meteorology has been slow and uncertain. Little, if anything more, is known now than 40 years ago of the immediate process of the condensation of invisible vapour into cloud, and of the resulting disturbance thereby established, or of the formation of rain from the cloud when formed. The same may be said of the fluctuations

of atmospheric temperature and pressure; but it is quite certain that until a clear appreciation of these and similar phenomena is obtained, meteorology can never take a position among the exact sciences. The Council therefore, earnestly recommends Fellows who have time and ability for the enquiry to prosecute the higher branches of meteorology, thus briefly alluded to, and to avail themselves as far as possible of the data collected by the Society for testing any theories which they may evolve from an abstract study of the question.

The Council have been accustomed for some time past to appoint standing committees to aid them in their labours: during the past year they have been assisted by a General Purposes Committee, including the President, the three Secretaries, and Messrs. Ellis, Greaves, and Latham; and an Editing Committee—consisting of Messrs. Laughton, Scott, and Whipple. They also appointed a Committee to inquire into and report on the causes of the alleged decrease in water supply—consisting of the President, Messrs. Eaton, Field, Greaves, and Latham.

Having regard to the rapid progress of late years in statistical Meteorology and the uncertainty that still prevails regarding important questions relating to the physics of the atmosphere, it seemed desirable in the opinion of the Council that the Society should supplement the ordinary observations by a series of well-conducted experiments destined to throw light on such questions as the vertical decrement of temperature, the rate of ascension of vapour, the height of cloud-strata, the variation in the velocity of the wind at different elevations, &c. They therefore appointed a Committee, consisting of the President, Dr. Gilbert, Messrs. Archibald, Eaton, Laughton, Russell, and Scott, to inquire into the feasibility of some definite meteorological researches of an experimental character. This Committee recommended that simultaneous observations of temperature should be made at the summit and base of Boston Church Tower, which is 270 feet high. On communicating with Dr. Siemens, F.R.S., that gentleman most kindly placed at the Society's disposal one of his electric thermometers to make temperature experiments at the top of the tower. The indicating apparatus will be fixed in the base of the tower, and the verger of the church has undertaken to take the readings simultaneously with those on the ground, and also to record the readings in the belfry, which is 170 feet from the ground.

Offers having been made to the Council to establish additional Climatological Stations, those at the following places, have been accepted viz.:—Dublin, Falmouth, Finchley, Helston, Killarney, the Regent's Park, Southend, Strelley near Nottingham, and Weymouth. These are all important stations, especially when taken in connection with those already existing. The Council congratulate the Society on the large number of Second Order and Climatological Stations from which they receive returns, amounting altogether to 88.

The following Second Order and Climatological Stations have been inspected by the Assistant-Secretary during the year, and were, with one or two exceptions, found in a generally satisfactory condition :—

Alston	Chester	Mansfield
Beacon Stoop	Churchstoke	Oakamoor
Belper	Cheadle	Ross
Blackburn	Cockermouth	St. Michael's-on-Wyre
Blackpool	Colwyn Bay	Scaleby
Brigg	Farley	Scarborough
Burghill	Hodsock	„ (St. Nicholas)
Buxton	Leaton	Seathwaite
Cardiff	Llandudno	Stapleton
Carmarthen	Loughborough	Strelley

Mr. Scott has also visited the station at Killarney in Ireland.

The Society's work is rendered more useful than it otherwise would be, as the copies of the monthly returns from 14 Second Order Stations, viz.:—

Babbacombe	Dartmoor	Scaleby
Buxton	Hillington	Scarborough
Carmarthen	Llandudno	Strathfield Turgiss
Cheltenham	Marlborough	Wakefield
Churchstoke	Ramsgate	

are printed *in extenso* by the Meteorological Office. Scarborough appears in the list for the first time, having been substituted for Kelstern, where observations have been discontinued.

A yearly abstract for Cheadle is also forwarded to the Meteorological Office, as well as Weekly Returns from the following nine stations, viz.:—

Blackpool	Cheadle	Llandudno
Brigg	Churchstoke	Marlborough
Burghill	Hillington	Strathfield Turgiss

During the past year a Manual has been prepared under the direction of the Council bearing the title—"Hints to Meteorological Observers, with Instructions for taking observations and Tables for their reduction." It contains the requisite information for observers as to the selection and management of barometers, thermometers, rain-gauges; how to take the direction of the wind, to register the amount of cloud, and with the aid of the tables to make accurate returns to the Society. As it was considered that this work would supply a want not only of our own observers, but of others, additional copies have been printed, and may be obtained from the Society's office, and the publishers.

The second annual Exhibition of meteorological instruments was held on March 16th, when nearly forty Hygrometers were exhibited, a list of which will be found at pp. 193-4 of Vol. VII. of the Journal. The exhibition was very successful and interesting, and drew together a large assemblage of Fellows and others interested in meteorology.

The Council have to record amongst numerous other gifts the presentation to them by Mr. Wragge of his instruments, at Oakamoor Railway Station, to enable the records to be continued after he had left the neighbourhood. The offer was accepted with thanks, and the station-master, Mr. Kettle, has continued the observations.

The want of information as to Papers previously published having often caused much loss of time amongst those desirous of ascertaining what had been done by others, the Council, at the suggestion of Mr. Greaves, decided on preparing an Index of all the Papers that have appeared in the publications of the old and present Meteorological Societies. This Index has been prepared at a cost to the Society of £19 11s. 9d., and issued to the Fellows. The Council trust that it will prove of considerable use not only to the Fellows and to the staff, but to other meteorologists who may be desirous of ascertaining what Papers have been published by our Society; and they are confident that, together with the Library Catalogue, it will assist in maintaining the unique position which this Society has taken in this respect.

It is believed that the Journal for this year compares favourably with its predecessors. The issue of the quarterly parts having been frequently delayed owing to the time occupied in verifying and discussing the observations from the Society's stations, the Council has decided upon separating the Quarterly Reports on the Meteorology of England from the Journal, and publishing them in a separate form under the title of *The Meteorological Record.*

Amongst the many valuable Papers which the Journal for 1881 contains, especial notice may be directed to that on the Frost of January 1881, prepared at the request of the Council by Mr. Marriott, which shows the great extent and extreme severity of the cold, especially in parts of Scotland; and to the Paper on Hygrometers, by the President, read in connection with the Exhibition on March 16th. The following is a list of the chief Papers read during the year before the Society:—

"*The History of British Meteorological Societies*, 1823-80." By G. J. Symons, F.R.S., President.

"*Relative Humidity.*" By C. Greaves, M.Inst.C.E., F.G.S., F.M.S.

"*The Frost of January* 1881, *over the British Isles.*" By William Marriott, F.M.S.

"*A Contribution to the History of Hygrometers.*" By G. J. Symons, F.R.S., President.

"*Comparison of Robinson's and Osler's Anemometers, with Remarks on Anemometry in General.*" By R. H. Curtis, F.M.S.

"*The use of Synchronous Meteorological Charts for determining Mean Values over the Ocean.*" By C. Harding, F.M.S.

"*The Climate of Fiji.*" By R. L. Holmes, F.M.S.

"*On the Gale which passed over the British Isles, October* 13*th*-14*th*, 1881." By G. J. Symons, F.R.S., President.

"*History of the Gale over the Atlantic Ocean, and on the coasts of the United Kingdom.*" By Charles Harding, F.M.S.

"*On the Structural Damage caused by the Gale, as indicative of Wind Force.*" By J. W. Peggs, Assoc. M.Inst.C.E., F.M.S.

"*The Rainfall of Cherrapunji, Assam.*" By Prof. J. Eliot, M.A., F.M.S.

"*On the Meteorology of Cannes, France.*" By W. Marcet, M.D., F.R.S., F.M.S.

"*Report on the Phenological Observations for* 1881." By the Rev. T. A. Preston, M.A., F.M.S.

As several years have elapsed since the Lightning Rod Conference was constituted, it may be well to remind the Fellows of the circumstances of its origin. At a Meeting of the Council on June 16th, 1875, the President (Dr. Mann) suggested 'that a Permanent Lightning Rod Committee be appointed to investigate and record accidents from Lightning, to inquire into the principles involved in the protection of buildings, to diffuse exact information regarding the best form and arrangements for Lightning Conductors, and to consider all phenomena of atmospheric electricity.' This suggestion was immediately adopted by the Council, and the following persons were appointed on the first Committee:—Dr. Mann, Mr. Brooke, Mr. Preece, Mr. Scott, Mr. Symons, Mr. Falkner of Manchester, Mr. Gray of Limehouse, M. Melsens of Brussels, M. Francisque Michel of Paris, and Professor Zenger of Prague. From various causes, however, not much progress was made. Ultimately at a Meeting of the Council on May 15th, 1878, it was resolved—'That the House Committee be instructed to address the following Societies:—The Royal Institute of British Architects, The Physical Society, and The Society of Telegraph Engineers, asking them to name delegates to co-operate in considering the desirability or otherwise of issuing a code of rules for the erection of lightning conductors, and to proceed in preparing a code if it is thought desirable.' In accordance with this resolution a letter to that effect was addressed to the above Societies, who entered warmly into the proposal. The following delegates were selected:—

Meteorological Society.—C. Brooke, F.R.S., *Past President* [the late]. E. E. Dymond, F.M.S., *Vice-President*. G. J. Symons, F.R.S., *President*.

Royal Institute of British Architects.—Prof. H. T. Lewis, F.S.A., *Vice-President*. J. Whichcord, F.S.A., *Past President*.

Society of Telegraph Engineers and of Electricians.—Latimer Clark, M.Inst.C.E., F.M.S., *Past President*. W. H. Preece, F.R.S., M.Inst.C.E., F.M.S., *Past President*.

Physical Society.—Prof. W. G. Adams, F.R.S., *Past President*. Prof. G. Carey Foster, F.R.S., *Past President*.

Co-opted Members.—Prof. W. E. Ayrton, F.R.S. Prof. D. E. Hughes, F.R.S.

The facts that the delegates have held 29 meetings with a total of 168 attendances, and that the Report and appendices consists of nearly 300 pages, sufficiently indicate how exhaustively the subject has been considered.

Several alterations have been made in the Society's rooms to adapt them to the additional work carried on, and to increase the comfort of the staff and of visitors. The following list, which has been carefully revised this year, shows the extent to which exchanges of Publications are made and the number of countries with which this Society is in correspondence.

FREE LIST.

J. = Quarterly Journal. R. = Meteorological Record.

J.	R.	Adelaide	Observatory.
J.	—	Batavia	Observatory.
J.	R.	Berlin	K. Preussische Statistische Bureau.
J.	R.	Bombay	Colába Observatory.
J.	R.	Brussels	Académie Royale.
J.	R.	"	Observatoire Royale.
J.	—	"	Rédacteur de "Ciel et Terre."
J.	R.	Budapest	K. Ungarische Central-Anstalt für Meteorologie.
J.	—	Cairo	Société Khédiviale de Géographie.
J.	R.	Calcutta	Meteorological Office.
—	R.	"	St. Xavier's College Observatory.
J.	R.	Christiania	Norske Meteorologiske Institut.
J.	R.	Copenhagen	Danske Meteorologiske Institut.
—	R.	Cracow	K. K. Sternwarte.
J.	R.	Dublin	Royal Dublin Society.
J.	R.	"	Royal Irish Academy.
J.	R.	Edinburgh	Royal Observatory.
J.	R.	"	Royal Society.
J.	R.	"	Scottish Meteorological Society.
—	R.	Falmouth	Royal Cornwall Polytechnic Society.
J.	—	Fiume	I. R. Accademia di Marina.
J.	—	Geneva	Société de Géographie.
J.	R.	Greenwich	Royal Observatory.
J.	R.	Hamburg	Deutsche Seewarte.
—	R.	Iowa	Weather Service.
J.	R.	Kew	Observatory.
—	R.	Klagenfurt	Sternwarte.
J.	R.	Leipzig	Sternwarte.
J.	R.	Lisbon	Academia Real das Sciencias.
J.	R.	"	Observatorio do Infante D. Luiz.
—	R.	Liverpool	Bidston Observatory.
J.	—	"	Literary and Philosophical Society.
J.	R.	London	Editor of "Nature."
J.	—	"	" "The Telegraphic Journal."
J.	R.	"	Institution of Civil Engineers.
J.	R.	"	Meteorological Office.
J.	R.	"	Royal Agricultural Society.
J.	R.	"	Royal Astronomical Society.
J.	R.	"	Royal Institution.
J.	R.	"	Royal Society.
J.	R.	"	Sanitary Institute of Great Britain.
J.	R.	"	Society of Arts.
J.	R.	"	Society of Telegraph Engineers.
J.	R.	Lyons	Commission Météorologique.
J.	R.	Madrid	Observatorio Astronomico.
J.	—	"	Sociedad Geografica.
J.	R.	Manchester	Literary and Philosophical Society.
J.	R.	Marlborough	Natural History Society.
J.	—	Mauritius	Meteorological Society.
J.	R.	Melbourne	Government Observatory.
J.	R.	Mexico	Ministerio de Fomento.
—	R.	Michigan	State Board of Health.
J.	R.	Milan	Osservatorio.
J.	R.	Modena	Osservatorio.
J.	R.	Moncalieri	Observatorio del R. Collegio Carlo Alberto.
—	R.	Munich	K. B. Meteorologische Central Station.
J.	—	Newhaven, U.S.	Connecticut Academy.
J.	R.	Oxford	Radcliffe Observatory.
J.	R.	Paris	Bureau Central Météorologique.
—	R.	"	Observatoire de Montsouris.
J.	R.	"	Société Météorologique de France.
J.	R.	Philadelphia	American Philosophical Society.

FREE LIST—*Continued.*

J. = Quarterly Journal. R. = Meteorological Record.

J.	R.	Prague	K. K. Sternwarte.
J.	R.	Rome	Ufficio Central di Meteorologia.
J.	R.	St. Petersburg	Physikalisches central Observatorium.
J.	R.	Stockholm	K. Svenska Vetenskaps-Akademie.
J.	R.	"	Meteorologiske Institut.
J.	R.	Sydney	Government Observatory.
J.	R.	"	Royal Society of New South Wales.
J.	R.	Tiflis	Physikalisches central Observatorium.
J.	R.	Toronto	Meteorological Office.
J.	R.	Upsala	Observatoire de l'Université.
J.	R.	Utrecht	K. Nederlandsch Meteorologisch Instituut.
J.	R.	Vienna	Hohe Warte.
J.	R.	"	Oesterreichische Gesellschaft für Meteorologie.
J.	R.	Washington	Chief Signal Office.
J.	R.	"	Smithsonian Institution.
J.	R.	Watford	Hertfordshire Natural History Society.
—	R.	Zi-Ka-Wei	L'Observatoire Magnétique et Météorologique.
J.	R.	Zürich	Schweizerische meteorologische Central-Anstalt.

The Balance-Sheet shows the great advance the Society is making in numbers and usefulness. It will be seen that the subscriptions for the year amounted to £324; the entrance-fees to £77, and the life compositions to £132, making with arrears of subscription a total of £608. The sale of Publications now constitutes a more considerable portion of the Society's income than previously, as above £30 have been received this year against £17 last year. This is very satisfactory, not only because of the increased amount, but especially as showing that the public are taking more interest in meteorology, and that our publications are more valued. The expenditure includes an increase in the cost of the Quarterly Journal and the Meteorological Record, which, with £14 spent for new type for symbols will raise the outlay to nearly £280. When, however, it is considered that the Record is now published in a separate form, and expensive diagrams have been included in the Journal, the increase is not large.

The following summary for the last four years shows the amounts received from subscriptions, entrance-fees, and life compositions:—

	1878.			1879.			1880.			1881.		
Subscriptions ...	£316	18	0	£357	14	0	£355	2	0	£399	6	6
Entrance-Fees ...	37	1	0	80	4	0	47	0	0	77	8	0
Life Compositions	36	0	0	144	0	0	144	0	0	132	0	0
	£389	19	0	£581	18	0	£546	2	0	£608	14	6

The total number of Life Fellows now on the roll of the Society is 111. Their aggregate Life Compositions have therefore been £1,332, and the property of the Society in the Funds and in Debenture stock is valued at £1,368. Irrespective therefore of the Library, Stock of Publications, Instruments, Furniture, &c., the Society has a surplus beyond all probable liabilities.

The Council have to draw especial attention to the following table, which shows how great an increase has taken place in the number of Fellows:—

Fellows.	Life.	Ordinary.	Honorary.	Total.
1880, December 31 ...	103	378	18	499
Since elected	+ 9	+68	...	+77
Since compounded	+ 1	− 1	...	0
Deceased	− 2	− 6	...	− 8
Retired	...	− 9	...	− 9
Defaulters	...	− 4	...	− 4
1881, December 31 ...	111	426	18	555

The following figures show the position of the Society for each year since it procured a Charter of Incorporation in 1866:—

1866...331	1870...340	1874...327	1878...425
1867...328	1871...314	1875...358	1879...473
1868...330	1872...309	1876...398	1880...499
1869...341	1873...308	1877...417	1881...555

The Society has to deplore the loss by death during the past year of seven of the Fellows, viz.:—

Sir Antonio Brady, elected June 4th, 1850;
Sir A. P. Bruce Chichester, Bart., elected March 17th, 1880;
Henry Dodd, elected June 18th, 1879;
Arthur Oldfield Hammond, elected March 19th, 1862;
William Humber, Assoc.M.Inst.C.E., elected January 15th, 1873;
Rev. William Percy Robinson, D.D., elected June 18th, 1879;
Frederick Symonds, M.R.C.S., F.R.M.S., elected May 7th, 1850; and
Henry John Yeld, M.D., elected January 20th, 1875.

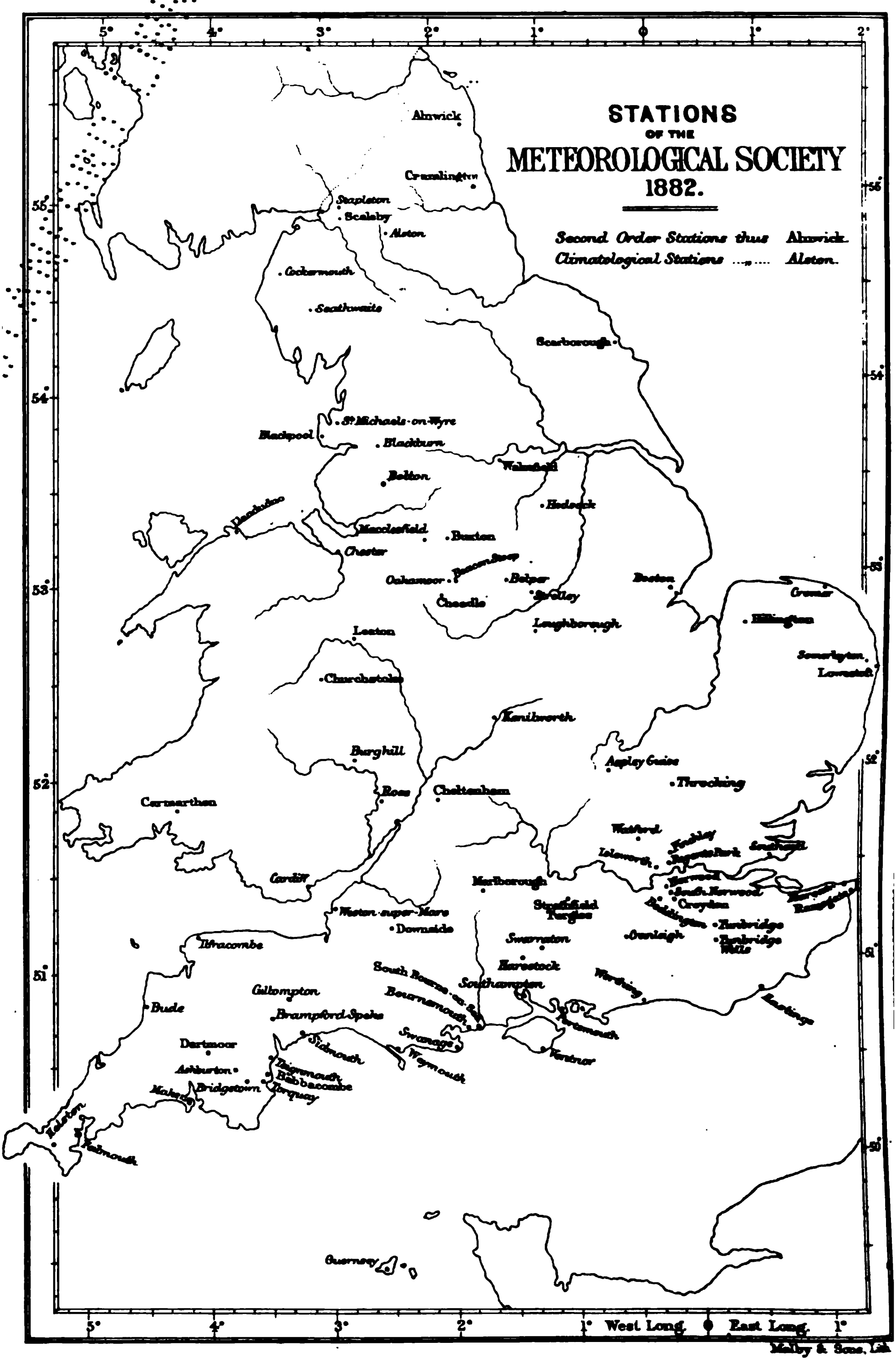
The following is a list of the instruments, the property of the Society and their locality at the present date, January 1882.

In the Society's Office:—

Fortin Barometer.
Kew Standard Thermometer.
Inspecting Instruments.
Bright-bulb Maximum Thermometer *in vacuo*.
Negretti and Zambra's Improved Six's Thermometer.
Denton's Maximum and Minimum Thermometer.
The Old Society's Barometer Tube (1837).

Lent to Mr. W. Dixon, Seathwaite:—

Maximum Thermometer.



Malby & Sons, Lith.

Minimum Thermometer.
Dry-bulb „
Wet-bulb „
Thermometer Stand.
Rain-gauge.

Lent to Rev. C. H. Griffith, Strathfield Turgiss :—
Bright-bulb Maximum Thermometer *in vacuo*.

Lent to Mr. E. E. Kettle, Oakamoor :—
Maximum Thermometer.
Minimum „
Dry-bulb „
Wet-bulb „
Thermometer Stand.
Rain-gauge.

Lent to Mr. W. Marriott, Norwood :—
Fortin Barometer.
Maximum Thermometer.
Minimum „
Dry-bulb „
Wet-bulb „
Earth „
Black-bulb-max. „
Bright-bulb do. „

Lent to Dr. J. Nicol, Llandudno :—
Kew pattern Barometer.

Lent to Mr. W. H. Tooker, Dartmoor :—
Kew pattern Barometer.
Maximum Thermometer.
Minimum „
Dry-bulb „
Wet-bulb „
Thermometer Stand.
Robinson Anemometer.
Rain-gauge.

APPENDIX I.

Report of the Assistant Secretary on the Inspection of the Stations during the Year 1881. (Plate XII.)

Alston, *August* 17.—This station is at Love Lady Shield, which is 2 miles E of Alston and 1,140 feet above sea level. The instruments are on the lawn, which is in the valley of the river Nent, a rapid flowing stream 20 feet wide. The valley runs N and S, and hills rise on either side 600 feet high. The whole district is hilly, the greater part being moorland. Hills

in the neighbourhood rise to the height of more than 2,000 feet above sea-level. Cross Fell, about 8 miles to the SSW, is 2,900 feet. All the instruments were in good condition. The thermometer-stand is a home-made one, and larger than the regular Stevenson pattern. The soil is limestone.—*Observer*, T. W. Dickinson.

Beacon Stoop, *March* 19.—The thermometer-stand and rain-gauge are placed on a small knoll at the extreme end of Beacon Stoop, the highest hill of the Weaver Range and the most elevated point in Staffordshire. The ground is nearly level on the north, but falls very abruptly on all other sides except the north-west. Mr. Wragge experienced great difficulty with the minimum thermometer, owing to the index being displaced by the wind. The index is shaken down by gales from the eastward, and up by gales from the westward. Minimum readings are considered as reliable only with winds below force 5; readings between force 5 and 7 may or may not be reliable. I suggested that a wall screen with maximum and minimum thermometers should be placed on the north side of a limestone wall in a moorland field about 370 feet north from the Stevenson stand, on ground a little lower than the highest point. Also that an additional rain-gauge should be placed about 800 feet north from the present one, where there is nearly level ground for some distance east and west.* These observations will be carried on till the 1st of July. The height of the rain-gauge is 1,216 feet and of the thermometers 1,220 feet above sea-level. The ridge of the hill is about 400 feet above the valley on the SW. The soil is limestone rubble.—*Observer*, C. L. Wragge, F.R.G.S., F.M.S.

Belper, *March* 22.—The thermometer-stand is placed on the grass beside the entrance walk to Field Head House. It is a little shaded by trees, but there appears to be a good circulation of air. The rain-gauge is placed in the kitchen garden, but as the site was not very good it will be removed to a more open situation. The garden is on the east side of the Derwent Valley and just out of the town. The soil is limestone.—*Observer*, J. Hunter, Jun., Assoc.M.Inst.C.E., F.M.S.

Blackburn, *August* 10.—This station is at the west end of Blackburn, on the Preston New Road, and on the northern slope of the town. The instruments are placed in a garden about 120 feet long and 85 feet wide, and 150 feet above the lowest part of the town. The thermometer-stand is of a peculiar construction, and is so arranged that the funnel of the rain-gauge and an evaporation-dish are let into the top, the rain being collected in a bottle in the southern half of the stand. The thermometers are fixed to the board dividing the stand into two parts and face to the north. The thermometers are only protected on the south, and consequently the sun can shine on them in the early morning and also in the evening. There are no air-holes behind the bulbs of the maximum and minimum thermometers, so that there cannot be a free circulation of air round them. The maximum thermo-

* This rain-gauge has since been started, and frequently collects nearly double the amount of the old.

meter was 2 feet 11 inches, the minimum 3 feet 9 inches, and the dry and wet 3 feet 6 inches above the ground. The maximum thermometer is not graduated on the stem. On examining the thermometers it was found that the minimum had about 2° of spirit at the top of the tube, and was consequently reading too low by that amount. The subsoil is sandstone.—*Observer*, W. B. BRYAN, M.Inst.C.E., F.M.S.

BLACKPOOL, *August* 11.—This station is situated at the South Shore, nearly 3 miles south of the centre of Blackpool, and about one-third of a mile from the sea-shore. The instruments are placed in the vegetable garden of Arnold House, on the Lytham Road; and the exposure is quite open. The ground in the whole of the district is flat. All the instruments were in a satisfactory condition. Soil, sand on turf, with clay below.—*Observer*, C. T. WARD, B.A., F.M.S.

BRIGG, *August* 20.—At the end of March Mr. Briggs removed from Kelstern to Brigg, and brought his instruments with him and had them set up, but he has not been able to take the Second Order observations. He will, however, endeavour to take the Climatological readings. The instruments are placed on the lawn in an open and well exposed situation, the ground being quite level in the whole of the neighbourhood. The soil is sandy.—*Observer*, D. G. BRIGGS, F.M.S.

BURGHILL, HEREFORD, *August* 30.—No change has been made in the instruments since the last inspection. A few weeks previously the dry-bulb thermometer was broken, since which time the minimum had been used as a dry-bulb, until a new instrument was obtained. Some shrubs and trees having grown up near the rain-gauge, Dr. Chapman undertook to procure a new gauge and place it in a more open situation. Soil, clay.—*Observer*, Dr. T. A. CHAPMAN.

BUXTON, *September* 6.—For some months past the instruments have occasionally been moved about, owing to the extensive alterations that are being made in the Hospital buildings. These will be completed in about two months, when a large grass plot will be railed off, and set apart for the instruments. A tower 40 feet high will also be erected at one corner of the Hospital grounds, on which will be mounted the sunshine recorder, the anemometer, and a rain-gauge. The instruments were in good condition, and since Dr. Sykes's return from Edinburgh the observations have been satisfactorily recorded. Soil, limestone.—*Observer*, Dr. E. J. SYKES, F.R.A.S., F.M.S.

CARDIFF, *August* 31.—The instruments are placed in a garden 40 feet long by 30 feet wide, having a wall 7 feet high on each side and a high house on the SSW. At the ENE end there is a stream about 15 feet below the level of the garden. On the N and NE, just outside there are some trees which almost overhang the garden and subtend an angle of about 60° at the rain-gauge. The exposure is therefore not as open as might be desired; in fact it is very confined. The ground in the district is flat, the nearest hills being 6 miles distant. The instruments were in a satisfactory condition. Mr. Adams adopts the plan of stocking the rainfall, so that he is able to check

the total fall at the end of the month. The soil is gravel on clay.—*Observer*, W. ADAMS, M.Inst.C.E., F.M.S.

CARMARTHEN, *August* 31.—As the thermometer stand is louvred at the front and back only, and there is no opening at the top, Dr. Hearder was requested to have a few holes made in the sides at the top and bottom, so as to allow of more ventilation. A new pair of dry and wet thermometers has been obtained since the last inspection, which work more satisfactorily than the old ones. Soil, clay.—*Observer*, Dr. G. J. HEARDER.

CHEADLE, THE HEATH HOUSE, *March* 21.—All the instruments were found in good working order and the observations appear to be satisfactorily made. Mr. Philips has it in contemplation to set up a sunshine recorder; the only place where it could command a complete view of the sun, while above the horizon, is on the tower. A site was selected for it on the south side of the tower, and a meridian line drawn.—*Observer*, J. C. PHILIPS, F.M.S.

CHESTER, *September* 8.—The instruments were all in good order. The maximum and minimum thermometers were, until recently, set in the afternoon, so that their readings did not always agree with the dry-bulb temperature at 9 a.m.; this has now been remedied, the thermometers being read and set at 9 a.m. Mr. Walker will shortly remove from Chester, so that the observations may possibly be given up, but he will try and induce one of the foremen of the lead works to carry them on. Soil, sand on clay.—*Observer*, A. O. WALKER, F.L.S., F.M.S.

CHURCHSTOKE, *September* 1.—This station was found in a satisfactory condition and the instruments in good working order. The only changes since the last inspection are, 1. That the barometer has been removed to another room and placed in a better light, and 2. That a sunshine recorder has been set up. Subsoil, Wenlock shale.—*Observer*, P. WRIGHT, F.C.S., F.M.S.

COCKERMOUTH, *August* 15.—Cockermouth lies in a valley, and Dr. Dodgson's house is at the bottom, only some 80 yards from the river Derwent. The instruments are placed on the lawn in a good sized garden; as lawn tennis is played here they are doubtless occasionally liable to some derangement. The stand is a double screen and has an additional board over the top, and is mounted on a single post; it is also painted green. On comparing the thermometers, it was found that the zero of the minimum had risen 0°·8, and the dry and wet 0°·2. The soil is gravel.—*Observer*, Dr. H. DODGSON, F.R.A.S., F.M.S.

COLWYN BAY, *September* 8.—This station is about three-quarters of a mile from, and 180 feet above, the sea. The instruments are placed in a large kitchen garden which slopes considerably from NW to SE. The garden is on the north-west side of a rather steep and narrow valley. The thermometer stand is placed on the north side of an asphalt path, so that there may possibly be some reflected heat arising therefrom. Mr. Walker's gardener left in July, so that the observations for the present have been discontinued, but they will most probably be resumed at the beginning of next year. Soil, loam on gravel.—*Observer*, A. O. WALKER, F.L.S., F.M.S.

FARLEY, *March* 19.—The instruments are placed in a garden on the south side of the house on the road to Oakamoor. The ground slopes from the NNE to the SSW, and drops considerably at some little distance to the Churnet Valley. The exposure is quite open from the ENE by S to NW. The garden is 640 feet above sea-level, and 800 feet above the bed of the Churnet, which is only a little more than half-a-mile distant SW. The soil is sandy loam upon white beds of the Keuper.—*Observer*, C. L. WRAGGE, F.R.G.S., F.M.S.

HODSOCK, *March* 23.—The ground in the neighbourhood is flat, but here it slopes a little to the south. A small stream, the river Ryton, flows close by, about half-a-mile distant on the east. The instruments are placed on a lawn in a well exposed situation, and about 150 feet from a pond on the SW. Mr. Mellish has a sunshine recorder mounted on one of the towers of the gateway, and it is well placed. The only obstruction that is likely to occur is a tree on the ENE. The subsoil is red sandstone with light sand on the top.—*Observer*, H. MELLISH, F.M.S.

LEATON, *September* 2.—The Rev. E. V. Pigott was away from home, but the gardener showed me the instruments, which seemed to be all right except the grass minimum thermometer, which had 4° of spirit at the top of the tube. The maximum and minimum thermometers required to be mounted quite horizontally and the stand to be painted. Mr. Pigott has no one to read the barometer during his absence, consequently the readings are sometimes incomplete. Soil, clay.—*Observer*, Rev. E. V. PIGOTT, M.A., F.M.S.

LLANDUDNO, *September* 5.—The trees in the garden having grown a great deal since the last inspection, so that the exposure for the rain-gauge had become very imperfect, Dr. Nicol has agreed to have some of the branches cut off. The position of the thermometers in the stand will be re-arranged so that the instruments may be more conveniently read. The mercury in the barometer being dirty and the vacuum not very decided, the instrument will be sent to the maker to be cleaned. The sunshine recorder is mounted on the roof of the old telegraph station on the summit of the Great Orme's Head, and is admirably situated. Soil, limestone.—*Observer*, Dr. J. NICOL, F.M.S.

LOUGHBOROUGH, *March* 25.—The instruments are placed in a small garden (70 feet long and 18 feet wide) surrounded by a brick wall 6 feet high on the SW side of the house. The exposure is fully open from SE to W. The ground is level in the whole of the neighbourhood, the nearest hills being on the SW, about 3 miles distant. The garden is about 1 mile from the canal and 1¼ mile from the river Soar. The soil is gravel and the subsoil clay.—*Observer*, W. BERRIDGE, F.M.S.

MANSFIELD, *March* 24.—The force of the wind appears to have been very much under-estimated, being only about half the proper amount. The observations have not always been taken punctually. The observer was requested to be more particular on this point, and to enter the time when the observations are not taken at the regular hours. The subsoil is sandstone.—*Observer*, W. TYRER, F.M.S.

OAKAMOOR, *March* 19.—The thermometer stand and rain-gauge are placed

in the station yard of the North Staffordshire Railway, midway between the line and the river Churnet. The ground is in the centre of the Churnet Valley, which is barely one-eighth of a mile in width; hills rise abruptly on both sides to 150 or 200 feet. The general soil is alluvial, but the instruments stand on sandy loam. This station was organised and the instruments provided by Mr. Wragge. The observations are taken by Mr. E. Kettle, the station master. (Mr. Wragge, on his removal from the neighbourhood, presented the instruments to the Society, so that the observations might be carried on under proper supervision.)—*Observer*, E. E. Kettle.

Ross, *August* 29.—This station is at the Graig, a little way out of Ross, on ground sloping from NE to SW. On the SE and S about 1 mile distant there is a hill which rises to the height of about 600 feet above sea-level. On the W about half a mile distant the ground slopes steeply to the valley of the Wye. The instruments are placed in a vegetable garden which is fairly well open. The Stevenson screen was mounted upon, but not fixed to, a table. The water-cup was placed immediately beneath the bulb of the wet thermometer. The maximum and minimum thermometers were also near the top of the screen. Mr. Southall undertook to have the position of the thermometers rearranged, so that the dry and wet shall be behind and have their bulbs 4 feet above the ground, and the maximum and minimum in front; the stand also is to be raised a little, firmly fixed, and fresh painted. On comparing the thermometer used for terrestrial radiation it was found that it read about 5° too low; there was no spirit at the top of the tube, and it appeared to be in good condition. Mr. Symons tested this thermometer in 1875, when it read about 2° too low. This is an old thermometer by Messrs. Negretti and Zambra, but it seems strange that the glass should have expanded so much by age. Soil, Old Red Sandstone.—*Observer*, H. Southall, F.M.S.

St. Michael's-on-Wyre, *August* 12.—This station is nearly midway between Preston and Fleetwood. The whole of the district is very flat, the nearest hills being 7 miles to the ENE. The instruments are placed in the kitchen garden of the Vicarage, which is 160 feet long and 170 feet wide, and is surrounded by a wall 8 feet high. The Vicarage grounds are sheltered by trees on the W, but otherwise the neighbourhood is very open. The river Wyre is only about 200 yards distant on the N. All the instruments were in good order and appeared to be correctly read. Soil, loam on clay.—*Observer*, Rev. P. J. Hornby.

Scaleby, *August* 16.—The instruments were all in good order, and the observations appeared to be punctually taken. The barometer has been moved since the last inspection to another room, where it is in a better light. The maximum thermometer, which is of Phillips' construction, got out of order on two occasions during the severe winter owing to the index being too long. Soil, loam on sand, with clay in the neighbourhood.—*Observer*, R. A. Allison, F.M.S.

Scarborough, *August* 19.—The thermometer-stand was moved a short time ago to the site selected at the last inspection, as the photographic studio

at the end of the garden was enlarged owing to the laying down of a new tramway. On comparing the thermometers it was found that the zeros of the dry and wet had risen $0^{\circ}\cdot4$. The sea temperature is taken every other day at the North Pier at high water by the man in charge of the pier.—*Observer*, F. Shaw, F.M.S.

Scarborough (St. Nicholas), *August* 18.—This station is in a shallow valley which runs N and S, and is about three-quarters of a mile from the sea on the N, and nearly 1 mile from the sea on the E. The instruments are placed on a grass plot 12 feet square in a large kitchen garden. The rain-gauge was at one corner of the plot, and was rather protected by peas growing close by; it will be moved to the opposite corner, where it will be better exposed. The instruments belong to Mr. Woodall, but the observations are taken by one of his gardeners. Soil, loam on clay.—*Observer*, J. McClelland.

Seathwaite, *August* 18.—All the instruments were in good working order, and the observations appeared to be accurately made.—*Observer*, W. Dixon.

Stapleton, *August* 16.—This station is 10 miles E of Longtown and 16 miles NE of Carlisle. The ground in the neighbourhood is very undulating and rather hilly. The instruments are placed in a small kitchen garden surrounded by a hedge at the foot of a hill which rises some 170 feet to the N. The exposure is quite open. There is a range of hills about 7 miles distant on the N and E which rise to the height of 1,500 feet above sea-level. The stand is a home-made one of the Stevenson pattern. Mr. Walker was requested to allow for a better circulation of air at the bottom. Soil, sand on limestone.—*Observer*, T. H. Walker, L.R.C.P., F.M.S.

Strelley, *March* 22.—This station is on the summit of the ridge dividing the valleys of the Leen and Erewash, the Leen being to the east and the Erewash to the west of Strelley. The ground in the neighbourhood, though not very hilly, slopes away rapidly, the highest point being about half a mile distant to the north. The instruments are placed in the kitchen garden, which is surrounded by a high wall. The thermometer-stand is 86 feet from the north wall, and about 150 from the other three. Mr. Edge has recently procured a sunshine recorder, which is placed on the top of a stone chimney on the garden wall, but the instrument will require shifting as there are some trees which intercept the sun's rays. The soil is New Red Sandstone immediately above the Coal Measures.—*Observer*, T. L. K. Edge, F.M.S.

APPEN-

ABSTRACT OF RECEIPTS AND EXPENDITURE

Receipts.

	£	s.	d.	£	s.	d.
Balance from 1880				66	2	2
Dividend on £800 M. S. and L. R. 4½ Debenture Stock	35	2	0			
Do. £386 18s. 0d. New 3 per Cents.	11	6	9			
				46	8	9
Subscriptions for 1878	1	0	0			
Do. for 1879	15	4	0			
Do. for 1880	44	5	6			
Do. for 1881	323	15	0			
Do. for 1882	15	2	0			
Entrance Fees	77	8	0			
Life Compositions	132	0	0			
				608	14	6
Meteorological Office:—						
Copies of Monthly Returns	100	0	0			
Do. Annual „	2	10	0			
Do. Weekly „	3	18	2			
Grant towards Inspection Expenses, (2 years)	50	0	0			
				156	8	2
Sale of Publications				80	19	4
				£908	12	11

DIX II.

FOR THE YEAR ENDING DECEMBER 31st, 1881.

EXPENDITURE.

	£ s. d.	£ s. d.
Journal, &c:—		
Printing Nos. 37-40	116 19 3	
Illustrations	30 13 6	
Authors' Copies	16 14 6	
Meteorological Record	43 9 0	
Registrar General's Reports	7 12 0	
		215 8 3
Printing, &c.:—		
General Printing	17 18 9	
Index of Publications	16 0 6	
Hints to Observers	32 4 0	
List of Fellows	8 8 6	
Forms	21 17 6	
Stationery	13 19 3	
Books and Bookbinding	16 10 6	
		126 14 0
Salaries:—		
Assistant-Secretary	150 0 0	
Computers	92 10 6	
Overtime	6 0 3	
		248 10 9
Office Expenses, &c.:—		
Rent and Housekeeper	48 8 8	
Furniture, Coals, and Insurance	10 12 9	
Postage	45 7 8	
Refreshments	12 15 4	
Petty Expenses	5 8 0	
Reporting Discussion at November Meeting	1 11 6	
Collecting Arrears of Subscriptions, &c.	0 11 7	
		124 15 6
Observations:—		
Inspection of Stations	45 18 7	
Observers at Dartmoor and Seathwaite	5 5 0	
Type for Symbols	13 19 0	
Instruments	0 15 4	
		65 17 11
		781 6 5
Balance:—		
At Bank of England	110 14 3	
In hands of Assistant-Secretary	16 12 3	
		127 6 6
		£908 12 11

We have examined the accounts for the year 1881, with the vouchers and the books of the Society, and find them to be correct,

JOHN SANFORD DYASON, } *Auditors.*
CHARLES HARDING, }

January 9th, 1882.

APPENDIX II.—*Continued.*

ABSTRACT OF ASSETS AND LIABILITIES ON JANUARY 1st, 1882.

Liabilities.

	£	s.	d.
To Subscriptions for 1882 paid in advance	15	2	0
„ Excess* of Assets over Liabilities	1719	9	1
	£1734	11	1

* This excess is exclusive of the value of the Library and Stock of Publications.

Assets.

	£	s.	d.	£	s.	d.
By Society's Money invested in New 3 per Cents., £386 18s., at 99⅝	384	9	6			
„ Society's Money invested in M. S. and L. R. 4½ Debenture Stock, £800, at 123	984	0	0			
				1368	9	6
„ Subscriptions unpaid, estimated at	107	0	0			
„ Entrance Fees	9	0	0			
„ Dividend on £800 M. S. and L. R. 4½ Debenture Stock	17	12	6			
„ Meteorological Office—Weekly Returns for 1881	5	2	7			
				138	15	1
„ Furniture, Fittings, &c.	40	0	0			
„ Instruments	60	0	0			
				100	0	0
„ Cash in hands of Bank of England	110	14	8			
„ Do. Assistant-Secretary	16	12	3			
				127	6	6
				£1734	11	1

JOHN SANFORD DYASON, CHARLES HARDING, } *Auditors.*

WILLIAM MARRIOTT, *Assistant Secretary.*

January 9th, 1882.

APPENDIX III.

Obituary Notice.

ntonio Brady was born on November 10th, 1811, and educated at n Grammar School. He entered the Civil Service of the Navy as a ᴈrk in the Royal Victualling Yard at Deptford. After serving in the acity at Plymouth and Portsmouth, he was promoted to head-quarters lmiralty at Somerset-House. Here he gave such satisfaction in the ə of his duties, that in 1854 he was made head of the Contract Office istrar of Public Securities; subsequently he assisted very materially anising that Office, and was appointed the first Superintendent of the chase and Contract Department. In 1870 he retired from the and received the honour of knighthood in recognition of the arduous emitting labours he had undertaken in connection with the Civil which extended over 40 years.

the time of his retirement till the day of his death he was most s for the public welfare, and devoted his time, health and means to various objects of social, educational and religious good, which ɜived his warm co-operation.

ed suddenly on December 12th, at his residence, Maryland Point, l.

ıtonio was elected a Fellow on June 4th, 1850, and served on the from 1854; being Vice-President in 1859-60 and 1863-64; and from 1865 till the time of his death.

APPENDIX IV.

List of Books Purchased.

ıalty Manual of Scientific Enquiry.—Originally edited by Sir John erschel. Fourth Edition, superintended by Rev. R. Main, F.R.S. 8vo.

ɛmeine Erdkunde.—Ein Leitfaden der astronomischen und physichen hie, Geologie und Biologie. Bearbeitet von Dr. J. Hann, Dr. F. v. tter und Dr. A. Pokorny. 8vo. (1881.)

ingault, J. B.—Economie Rurale considérée dans ses rapports avec la la Physique et la Météorologie. Tomes I. et II. 8vo. (1843-4.)

sh Association for the Advancement of Science.—Report of for 1876, 8vo. (1877.)

ɔlopædia Britannica.—Ninth Edition. Vol. XII. 4to. (1881.)

ıc, Dr. P.—De la Météorologie dans ses Rapports avec la Science de et principalement avec la Médécine et l'Hygiène Publique. Tomes I. 3vo. (1854.)

ʼan, R., F.R.S.—An Estimate of the Temperature of Different Latitudes. 787.)

ıture, 1881. 4to. (1881.)

ical Magazine for May, 1881. 8vo. (1881.)

ɛll, R.—North America, its Agriculture and Climate, containing Observ on the Agriculture and Climate of Canada, the United States, and the f Cuba. 8vo. (1857.)

ɔity Remembrancer: being historical narratives of the Great Plague on, 1665; Great Fire, 1666; and Great Storm, 1703. Two Vols. 8vo. (1769.)

, A.—An Enquiry into the Nature and Course of Storms in the Indian outh of the Equator. 8vo. (1845.)

es" Register of Events in 1878 and 1880. 8vo, (1879 and 1881.)

APPENDIX V.

Donations received during 1881.

Presented by Societies, Institutions, &c.

Adelaide, Royal Society of South Australia.—Transactions and Proceedings and Report, Vol. III.

Bombay, Meteorological Office.—Report on the Administration of the Meteorological Department of Western India for the year 1880-81.

Brisbane, General Register Office.—Report on the Vital Statistics, Nov. 1880 to Sept. 1881.—Preliminary Statement of Census for the year 1881.

Brussels, Académie Royale de Belgique.—Bulletins. Tomes XLVI.-L.—Annuaire, 1879-81.

Brussels, Observatoire Royal.—Annales Météorologiques, Observations des Stations Climatologiques, Jan. to April, 1880.—Annales Météorologiques de Bruxelles, Nov. and Dec. 1880.—Bulletin Météorologique Oct. 1880 to Nov. 1881.—Observations Météorologiques faites aux stations Internationales de la Belgique et des Pays Bas, June 1879 to Jan. 1880.—Annuaire, 1880, 1881, and 1882.—Annales Météorologiques, Deuxième Série. Tome I.

Brussels, Société Belge de Géographie.—Bulletin, Vol. IV., No. 5.

Budapest, K. Ung. Central-Anstalt für Meteorologie und Erdmagnetismus.—Jahrbuch, 1878 and 1879.

Calcutta, Meteorological Office.—Report on the Meteorology of India in 1878.—Report on the Administration of the Meteorological Department of the Government of India in 1879 to 1880.—Registers of Original Observations reduced and corrected, April 1879 to July 1880.—Indian Meteorological Memoirs. Vol. I., Pt. V.

Calcutta, St. Xavier's College Observatory.—Meteorological Register, July 1880 to June 1881.

Canada, Meteorological Service.—Report for 1879.

Cape Town, Meteorological Commission.—Report for the year 1880.

Christiania, Norwegian North Atlantic Expedition.—Chemistry. By H. Tornoe.—Zoology, Fishes. By R. Collett.—Zoology, Gephyrea. By D. C. Danielssen and Johan Koren.

Christiania, Norske Meteorologiske Institut.—Jahrbuch, 1879 and 1880.—Oversigt over Veirforholdene i Norge i Aaret, 1880. Ved K. Hesselberg.

Copenhagen, Danske Météorologiske Institut.—Bulletin Météorologique du Nord, Dec. 1880 to Nov. 1881.—Meteorologisk Aarbog for 1880. Parts 1 and 3.

Cracow, K. K. Sternwarte.—Meteorologische Beobachtungen, Oct. 1880 to 1881.

Dublin, General Register Office.—Weekly Returns of Births and Deaths.

Dublin, Royal Irish Academy.—Proceedings: Science, Vol. III. Ser. II. Nos. 5-6; Polite Literature and Antiquities, Vol. II. Ser. II. No. 2.—Transactions: Science, Vol. XXVIII., Pts. 1 to 5. Polite Literature and Antiquities, Vol. XXVII., Paper 4.

Edinburgh, General Register Office.—Quarterly Returns of Deaths, Births and Marriages, 1855 to Sept. 30th, 1881.

Edinburgh, Royal Society.—Proceedings, Nos 105 to 107.

Falmouth, Royal Cornwall Polytechnic Society.—Forty-eighth Annual Report, 1880.

Fiumi, I. R. Accademia di Marina.—Meteorological Observations, Oct. 1880 to Oct. 1881.

Geneva, Observatoire.—Résumé Météorologique de l'année 1879. Par Prof. E. Plantamour.

Geneva, Société de Géographie.—Le Globe, Tome XIX. Liv. 4; Tome XX. Liv. 1-5.

Greenwich, Royal Observatory.—Report of the Astronomer Royal to the Board of Visitors, June 4, 1881.—Magnetical and Meteorological Observations, 1879.—Description of the Greenwich Time Signal System.

Hamburg, Deutsche Seewarte.—Witterbericht.—Monatliche Uebersicht der Witterung 1879, April to Nov.; Aug. 1880 to July 1881.—Meteorologische Beobachtungen in Deutschland fur 1878.—Aus dem Archiv der Deutschen Seewarte 1879 and 1880.

Iowa, Weather Service.—Weather Bulletin.—Report for 1881.

Leipzig, Meteorologische Bureau.—Bericht, 1880.

Leipzig, Sternwarte.—Monatliche Berichte über die Resultate aus den meteorologischen Beobachtungen angestellt an den Königlich Sächsischen Stationen im Jahre 1879.

LISBON, ACADEMIA REAL DAS SCIENCIAS.—Jornal de Sciencias Mathematicas, Nos. 24 to 29.—Memorias. Tomo V., Parte II.; Tomo VI., Parte I.

LISBON, SOCIEDADE DE GEOGRAPHIE.—Boletim 2a Serie, Nos. 1-2.

LIVERPOOL, LITERARY AND PHILOSOPHICAL SOCIETY.—Proceedings, Vols. XXXIII. and XXXIV.

LONDON, ARMY MEDICAL DEPARTMENT.—Report for 1879.

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APPENDIX VI.

REPORTS OF OBSERVATORIES, &c.

THE METEOROLOGICAL OFFICE. Prof. H. J. S. Smith, F.R.S., Chairman of Council; Robert H. Scott, F.R.S., Secretary; Capt. H. Toynbee, F.R.A.S., Marine Superintendent.

Marine Meteorology.—For the first half of the year the staff was employed in completing the charts for the region lying near the Cape of Good Hope. The general features of the different series of these charts were described in the last Report.

In July the clerical labour on this work was completed, with the exception of the final revision of the charts in their progress through the press, and the preparation of the explanatory Remarks to illustrate them. These latter were completed in the course of the autumn, and the proofs have been finally signed for press.

According as members of the staff were set free from the above work they were employed in the completion of the charts of Sea Surface Temperature for the entire globe and for the four cardinal months February, May, August, and November, as described in the last Report. These charts are now nearly finished and will shortly be published, with some brief explanatory remarks.

The Council have decided to undertake the preparation of Pressure Charts for the oceans of the globe on a plan similar to that adopted for the Temperature Charts just described, and good progress has been already made in the extraction of the data.

The subject of the discussion of Atlantic weather for a definite period, which has been suggested to the Meteorological Council on more than one occasion, and notably by a letter from the Council of this Society, of June 17th, 1880, has been carefully considered. It is now proposed to invite all British captains to co-operate by promising observations for one year. The period selected is from August 1st, 1882, to August 31st, 1883, being that already adopted for the international scheme of simultaneous observations in the Arctic Regions on the plan proposed by the late Lieut. C. Weyprecht. The coincidence in time of these two systems of observation cannot fail to add greatly to the value of each set of records.

With reference to Arctic meteorology, it may be said that good progress has been made by Mr. R. Strachan in his discussion of the arrears of existing materials relating to the Arctic Regions. Part III. of his "*Contributions*" is nearly ready.

It will contain the records of some British expeditions of which no meteorological results have as yet seen the light. For instance, those conducted by Sir R. Collinson at Walker Bay, Cambridge Bay, and Camden Bay.

Weather Telegraphy.—There have not been any changes of consequence in this department during the year as regards the arrangements for these islands, but as concerns the responsibilities of the office for warning the coasts of our continental neighbours a material alteration has taken place.

Ever since the establishment of Storm Warnings in this country, in 1860, the duty of warning certain parts of the French Coast, through the Ministère de la Marine, has been undertaken by the Meteorological Office. The recently effected unification of the French system in the Bureau Central under M. Mascart, has, however, as a natural consequence, led to the centralisation of the storm warning system of France in that office, and accordingly the Ministère de la Marine, while gracefully acknowledging the services rendered to the French Navy by the Meteorological Office during a period of over twenty years, has intimated that for the future the warnings for the whole of France will be issued by the Bureau Central.

With reference to the *Weekly Weather Report*, which has now been issued regularly for four years, the Council have resolved to invite gentlemen interested in the connection of meteorology with agriculture to offer opinions as to possible improvements in the matter or the form of the publication, so as to adapt it as fully as possible to the requirements of scientific agriculturalists. Replies from the Council of this Society and from more than one of the Fellows have been received, and will be taken into consideration at an early date.

Land Meteorology.—The publication of the *Quarterly Weather Report* has been resumed by the appearance of Part I., 1876. This is considerably enlarged, as compared with its predecessors, and contains a series of two weather charts for each day, and in addition tables of monthly means for the stations of the second order and for the telegraphic reporting stations. The absence of the last-named tables from all previous British publications has been felt as a serious inconvenience by students of climatology at home and on the continent. The part contains two special appendices, the first, a comparison of the automatic records at Greenwich and Kew for the year 1875, and the other, a report on the experiments made at the Pagoda in the Royal Gardens, Kew, on the influence of height on the distribution of temperature and humidity. The curves of the self-recording instruments having been engraved in the office for some years in advance of the text, the Council have resolved to issue these, for the years 1879 and 1880, in anticipation of the printed matter, which will ultimately appear, to accompany them.

The Council have for some time been desirous to prepare a meteorological atlas for the British Isles, based on the observations of the last 20 years. They have entrusted the preparation of the tables to Mr. Marriott, who has been most kindly allowed by the Council of the Society to undertake the work and to make free use of any materials to be found among the Society's archives in order to render the charts as perfect as is possible. These charts are now in an advanced state, but the deficiency of information from Ireland renders the deduction of trustworthy mean values for that country extremely difficult.

The Council have besides made arrangements with Mr. Symons for the publication of monthly mean rainfall values for as many stations as could show an uninterrupted record for the 15 years ending with 1880. The number of such stations has turned out to be 366; so that the publication, now in the press, cannot fail to give a very full representation of the main features of the rainfall of the United Kingdom.

The Council have also intrusted to a committee of eminent chemists an inquiry into the chemical and physical constitution of London fog. The first preliminary experiments on the subject having shown that the operations must be conducted on large volumes of air, a suitable aspirator has been prepared, and the experiments will be conducted at all favourable opportunities.

In conclusion, it only remains to express the deep regret of the office that in conducting an experimental inquiry on its behalf a valuable life has been lost. During the autumn Capt. J. Templer was employed in making occasional ascents for the office in a balloon lent by the War Office, in order to throw light on the vertical distribution of various meteorological phenomena. On two

occasions Capt. Templer was accompanied by a clerk from the Meteorological Office. On December 10th he ascended from Bath, accompanied by Mr. W. Powell, M.P. (himself an experienced aeronaut), and Mr. Agg Gardner. The balloon went southwards, and on descending rapidly near Bridport, Capt. Templer and Mr. Gardner were thrown out. The balloon drifted out to sea, and nothing has since been heard of it or its occupant, Mr. Powell; the only relic found has been a broken thermometer frame which was washed ashore on Portland Bill ten days after the accident.—*March 20th*, 1882.

ROYAL OBSERVATORY, GREENWICH. W. H. M. Christie, M.A., F.R.S., Astronomer Royal.—The work of the meteorological department of the Magnetical and Meteorological Observatory has been continued on the same general plan as in former years.

The zero of Thomson's Electrometer during the early part of the year 1881 showed a tendency to wander in position, the appearances suggesting fault in the bifilar suspension, which, indeed, on June 7th finally gave way: it was renewed on June 13th. There was afterwards some little tendency of the same kind, which, however, has since disappeared.

The volume for the year 1879 has been published since the date of the last report, and that for 1880 is nearly complete.

Mr. H. S. Eaton has been supplied at his own request and expense with a copy of the observations of the temperature of the air made daily at the Royal Observatory, previous to the establishment of the magnetical and meteorological observatory in the year 1840. The series extends from 1807 to 1840, the observations having been made (excepting in the earlier years) several times each day, and including readings of a maximum and minimum thermometer.—*February* 1882.

ROYAL OBSERVATORY, EDINBURGH. Prof. C. Piazzi Smyth, F.R.S.E., Astronomer Royal for Scotland.—Pending the inquiry now being made into the relation of the Edinburgh Observatory to the Government, no report is given out.—*January 7th*, 1882.

KEW OBSERVATORY. G. M. Whipple, B.Sc., F.R.A.S., Superintendent.—The routine meteorological work, as described in former reports, has been maintained throughout the year unchanged and uninterruptedly. The total number of entries of various meteorological data has amounted to over 60,000, an average of more than 170 a day.

The tabulation of the curves given by the electrograph has been commenced, and a suitable glass scale, arranged on a plan devised by Mr. Whipple, having been constructed by Mr. Baker, the average hourly tension of atmospheric electricity at the collector of the electrograph has been determined for every hour in 1880, except in those cases where registration failed either from disturbance or instrumental defect. From these values the daily, monthly and annual means have been deduced, together with other facts bearing on the relations existing between atmospheric electricity and different meteorological phenomena. Some results of this investigation were submitted by the superintendent, by permission of the Meteorological Council, to the meeting of the British Association at York, in a paper which has since been ordered by the General Committee to be printed *in extenso* among their Reports.

The number of the instruments verified at the Observatory during the year amounted to 6,460.

The schedule of fees payable for the verification of instruments has been revised, and copies of the new scale, together with particulars as to the transmission, &c., of instruments to and from the Observatory for the purpose of

comparison, have been widely distributed amongst opticians and instrument makers.

From time to time comparisons have been made between the two Welsh Standard Barometers, the old Royal Society Standard, and Newman No. 34, the working Standard of the Observatory. The Portable Standards of the Observatory have also been employed in making comparisons of the Standard Barometers at the Hydrographic Office, Admiralty; the University Museum, Oxford; and the Royal Engineering College, Cooper's Hill.

The large difference formerly observed in the heights of the mercurial column in the flint and crown glass tubes of the old Royal Society Standard Barometer has been found not to exist in the re-filled tubes, and the mean difference between their indications is now less than 0·001 inch.

The Committee has exchanged Standard Thermometers with the John Hopkins University, U.S.A., Professor Rowland having, on the occasion of his recent visit to this country, presented the Observatory with a Standard Baudin 7,835—which he has compared very closely with his other standard instruments.

The Committee has received very gratifying testimony as to the accuracy of the standard thermometers constructed at the Observatory. In a paper contributed to the *American Journal of Science*, Dr. Leonard Waldo, of the Winchester Observatory, Yale College, U.S.A., remarks that after a critical examination of three Kew standard thermometers, in which every degree was separately measured, entailing no less than 2,300 micrometer readings, he came to the conclusion that their errors are practically insensible and too small to be detected with certainty.

Professors Thorpe and Rücker have also been engaged in testing very minutely three similar instruments made for them at Kew. In a paper read at York before the British Association, Professor Rücker stated " they had subjected the Kew thermometers to the most rigorous test possible, and they were able to announce that in one instrument the errors left, after the application of Welsh's method of calibration and graduation, were not greater than four-thousandths of a degree Centigrade, and in no case did they much exceed one-hundredth of a degree. As it is impossible to read on these thermometers less than a hundredth of a degree with certainty, Welsh's method as applied at Kew is almost perfect."

At the request of the Meteorological Council the meteorological registers of the Observatory were searched from 1843 to the end of 1880, and an enumeration made of all the observations of fog and mist recorded in them.

On going through the books of the Observatory for the purpose of compiling the above-mentioned tables, it was found that the volumes containing observations made between January and June 1845, and from August 1848 to December 1853, were missing. Professor G. Carey Foster discovered that the volumes containing the MSS. results for 1845 and from 1849 to 1851 were in the library bequeathed by the late Sir F. Ronalds to the Society of Telegraph Engineers and Electricians, whereupon the Council of that Society most courteously directed that these records should be restored to the custody of the Kew Committee.

Further search has failed to bring to light any regular records of observations made between August 1852 and January 1854; and it is believed that none were made during the interval which elapsed between the discontinuance of the system of observations organised under the superintendence of Sir F. Ronalds and that established by Mr. J. Welsh, after his appointment as Superintendent.

The experiments at the Observatory for determining the relative merits of different patterns of thermometer-screens, as described in the Report for 1879, were terminated in October, and the readings of Mr. Jordan's glycerine barometer were also discontinued at the end of the year.—*January 10th*, 1882.

Radcliffe Observatory, Oxford. E. J. Stone, M.A., F.R.S., Radcliffe Observer.—The set of photographic instruments for the continuous registration of atmospheric pressure, temperature, and humidity; the Beckley anemometer; the self-registering rain-gauge; and the sunshine recorder, have been in regular use throughout the year. The eye-observations of the standard instruments, for comparison with the photographic records, have been regularly taken.

Observations are made at 8 a.m. and 8 p.m., and forwarded to the Meteoro-

logical Office, London; also at 0·8 p.m. for the Chief Signal Office, War Department, Washington, U.S.A.

The results of both eye-observations and automatic records for the year 1880 have been discussed and are in the hands of the printer.—*January 23rd*, 1882.

STONYHURST COLLEGE OBSERVATORY. Rev. S. J. Perry, M.A., F.R.S.—A systematic watch for aurora has been undertaken in connection with the work of M. Sophus Tromholt, of Bergen, Norway. The French synchronous meteorological observations have been discontinued, and those of the United States altered slightly in time. Great attention has been paid during the year to the time of the flowering of plants, and 127 specimens belonging to 42 natural orders have been duly entered on our list.—*January 16th*, 1882.

NOTES OF EXPERIMENTS ON THE DISTRIBUTION OF PRESSURE UPON FLAT SURFACES, PERPENDICULARLY EXPOSED TO THE WIND. By R. H. CURTIS, F.M.S., and C. E. BURTON, B.A., F.R.A.S.

[Read February 15th, 1882.]

IN the present state of aero-dynamics, it seems to be impossible to make an *à priori* investigation of the distribution of pressure on a surface exposed to the impact of this fluid in motion, even in the simple case stated above, without introducing such limitations as render the solutions arrived at widely divergent from the results obtained by the experiments hitherto made.

We therefore proposed to attack the problem from the experimental side only, by a method which, as far as we know, has not been applied in the case of air: namely, the application of Pitot's tube, suitably modified in form, to the simultaneous measurement of the pressures at the centre and at any excentrically situated point of a pressure plate of known dimensions. After several trials of different forms of apparatus, we adopted the arrangement now to be described, with which the results published in this paper have been obtained.

Description of Apparatus.—A square board was pierced with holes ¼ inch in diameter and perpendicular to its surface at known distances from its centre, where there was a hole similar to the others named by us the 'Standard' hole. At the back of the board was supported a glass jar of uniform diameter, in a vertical position (Fig. I., p. 140). In this jar were vertically supported two glass tubes of uniform bore, much less than the diameter of the jar, to the bottom of which they almost reached. The tubes bore scales which were not too fine to be easily read at a glance (in one case a scale division equalled 0·047 in. in another 0·068 in.), the fractions of divisions being estimated. The upper ends of these glass tubes were inserted air-tight into caoutchouc tubes of equal length, terminated by slightly conical brass nozzles, which, when the instrument is in use, are inserted into any two selected holes in the board, one of the holes being always that at the centre of the board, namely, the 'Standard' hole (Fig. II., p. 140). The jar having been partly filled with water, the brass nozzles inserted in the 'Standard' and in the hole to be compared therewith, and the face of the board presented to a current of air, the

Fig. I.

Pressure Board, 1-ft. square, mounted on Tripod Stand.

Fig. II.

Jar and Tubes used in Pressure Expe
ments.

statical pressure produced by the change of velocity of air due to the presence of the board causes a depression of the water within the tubes below its original level. The amount of the depression in each tube is read off as quickly as possible; or, as an alternative method, the amount of the depression in that tube which shows the greatest change of level is observed, and the ratio of the depressions in the two tubes is estimated at the same moment. A pair of such readings, or a reading and an estimated ratio, forms or form an 'observation,' and ten or twelve 'observations' constitute a 'set.' At the end of the first 'set' of observations on a pair of holes the nozzles are interchanged, and a second 'set' of 'observations' is made; the remaining holes in the board being fitted with plugs which enter sufficiently far to render the front surface of the board continuous, save where the nozzles are inserted.

Two such boards, 1 foot and 4 feet square respectively, have been prepared and fitted with water-pressure gauges of the kind and in the manner which has just been described; but the experiments with the larger surface are not sufficiently advanced (mainly on account of the difficulties which we have until recently encountered in securing a fair exposure for a pressure-plate of such dimensions), that we do not propose to do more than allude to them in this preliminary note (See *Addendum*). The distribution of wind-pressure upon the smaller, and more manageable, board has, however, been studied at every opportunity which presented itself, and we hope that a summary of the results obtained may be of interest to the Society, especially if they are considered in connection with recent observations on the effect of gales upon obstacles of various forms.

In using the small pressure-plate it was supported at a height of 4 or 5

feet from the ground, on a light tripod stand, its front surface being set perpendicular to the prevailing direction of the wind by the aid of a 'dog-vane' attached to the upper part of the stand in such a position that it could be seen even while the observer was watching the changes of level in the gauges. Observations were made only when the level of the water in the gauges remained steady for several seconds together, and the vane was at the same time perpendicular to the plane of the board. By attending to these precautions we hoped to secure observations made when the axis of the stream-line systems in front of the board was coincident with the central-normal of the pressure-plate. If these lines be not coincident, the point of application of the resultant-pressure lies between the centre and the advanced edge of a pressure-plate of symmetrical form, and tends to restore the plate to a position normal to the direction of the wind; as may be seen from the behaviour of a kite, or from consideration of the following simple experiment [A light flat plate suspended symmetrically by a string and carried horizontally through the air, is found to set itself at right angles to its path, no matter what its original position may have been.]. If, as in the case of our pressure plate, slight deviations from the proper position are of continual occurrence, owing to the unsteadiness of the wind; and if the pressure per unit of area of the plate decreases from its centre to its edge, then the preceding considerations show that the lines of equal pressure on the plate follow the changes of the wind; and it is not difficult to see that the effect of such changes will be to introduce a small systematic error into the observations. To the cause just mentioned we attribute the abnormally large ratios of excentric to central pressure occasionally observed by us, but we hope to find means of eliminating the errors which have, or may have, been produced thereby.

A diagram (Fig. IV.) representing the system of holes in the small pressure-plate and the letters designating them is here given, as well as a short table of the pressure ratios hitherto determined for each zone of the pressure-plate, and for each group of similarly placed holes. The curved lines upon the diagram represent roughly and provisionally the distribution of wind-pressure upon the small plate as deduced from a preliminary examination and comparison of the observations, and are not to be taken as complete or final. We hope in addition to obtain more observations with the small plate, making use of all the areolæ in the diagram, under differing conditions as to wind velocity, &c.; and at some convenient time to supplement our work with square plates, by studying in the same or a similar manner the distribution of wind-pressure on plates of other, *e.g.* circular forms.

It has occurred to us that the observed diminution of pressure in the tube connected with a marginal hole, as compared with that felt in the 'Standard' tube, might be attributed to the fact of the viscosity of the air streams passing towards the edge of the plate dragging the air partially out of the 'marginal' hole and tube, and that the objection might be met by the consideration that the layer of air in contact with the front of the board is practically quiescent, on account of the friction between it and the solid in contact

with it, and that the air in the hole is protected by this very slowly moving layer beyond it from the more rapidly moving layers. The case differs from that of the outlet tube in Hagemann's anemometer, in which the resolved component of the wind's motion parallel to the axis of the tube is directed outward, while in the case of the hole in the pressure-board it is inward.

Addendum.—Since the preceding paragraphs were written, Mr. Dowson, F.M.S., of Geldeston, who has kindly undertaken to conduct the experiments for us, has completed two series of observations for each of the 16 holes of the 4-feet board. The first series was made almost exclusively with light wind, and the second with wind of about force 6 of Beaufort's Scale. The mean results, which agree very closely in both series, show a system of pressure-lines (see Fig. III., p. 144) differing a good deal from that obtained from the results of the observations made with the 1-foot board:—The 90 per cent. line falls at about half-way between the centre and the edge of the board, and the 80 per cent. line very nearly on the edge. The extension of the lines towards the corners of the board, making them convex towards the centre, disappears, the lines being slightly convex towards the edges of the board, and generally the distribution of the wind-pressure upon the board is much more uniform than is the case with the board 1 foot square.

In the first series the amount of the depression in the tubes was generally less than $\frac{3}{10}$ of an inch, and it is needless to point out that the liability to error in estimating the difference of level in the two tubes is much greater when the total quantity to be read off is so small, than when, as in the second series, the amount of the depression is greater. In the second series it probably averaged 6 or 7 divisions, and occasionally amounted to as much as 12 or 18 divisions. The errors of reading are, however, probably of opposite signs, and therefore they may safely be trusted to cancel each other.

There are one or two other points to which it is right to call attention here, since they may be considered to bear directly on the value of the results obtained by the method we have used.

1st. There is no arrangement in the mounting of the large board by which it is enabled to shift under the influence of the wind, and take up a position perpendicular to it; the observer has, therefore, to wait until he sees by the 'dog-vane' that the direction of the wind current is suitable before he can make his observation; and even with care there would always seem to be a danger of error from the direction of the wind not being quite normal to the board; we attribute to this the fact that occasionally the ratios observed vary very much without any apparent cause, as, for example, ·6, 1·3 and ·7, in three consecutive readings made apparently under exactly similar conditions, except as regards force of wind.

2nd. It has occurred to us that the shape of the board may, owing to weather, have undergone some change during the course of the observations, and have become warped.*

* Mr. E. T. Dowson, in a letter dated March 28th, writes:—

"The board was slightly warped from the commencement of the experiments, but I do not think that it has materially increased. The board was always kept indoors except when intended for early or immediate use, and I am almost certain that during

To obviate these difficulties the plate should be of iron, and mounted on a ot, free to move in azimuth under the influence of the wind, or easily l promptly adjustable by the observer.

The total number of observations made by Mr. Dowson in the two series been upwards of 1,100, besides nearly 300 which were rejected owing to efect in the original mounting of the board; and we desire to express great obligation we are under to that gentleman for the very kind and dy assistance which he has rendered in undertaking, at considerable peral inconvenience, the observations with the 4 feet board.

Some further observations have also been made with the small board by Mr. rton, at Loughlinstown, Co. Dublin, and Fig. V., p. 145, is a diagram of ssure-lines obtained from some recent observations; they agree, in general, y closely with the lines in Fig. IV., p. 144; the convexity toward the centre ng retained, while the pressure is more nearly uniform over a larger area the centre of the plate, and the 80 per cent. and 70 per cent. lines fall rer to the edge of the board, and are more crowded together; the progation of the lines towards the corners of the board is however very rked. Some observations of the pressure near the edge of the plate e made during a gale on Monday last (Feb. 13th, 1882), and a mean of ut 40 observations for each hole gives the pressure on that part of the rd as about $\frac{7}{10}$ of that existing at its centre.

TABLE I.

RESULTS FROM SMALL BOARD (1 FOOT SQUARE).

Hole.	Ratio of distance of Hole from Centre to distance from Centre to edge of Board in same direction.	Mean Reading.	No. of Sets of Observations.	Mean Reading for Group of Holes similarly situate on Board.
B.	0·88	0·67	5	0·72
C.	0·86	0·77	2	
E.	0·86	0·71	3	0·66
F.	0·86	0·67	1	
H.	0·86	0·60	1	
R.	0·66	0·84	1	0·84
P.	0·45	0·81	1	0·81
L.	0·46	0·91	1	0·84
G.	0·41	0·82	1	
M.	0·42	0·79	1	

se experiments it has never been subjected to a shower of rain. The concave side s the observer when experimenting, and the warping occurs chiefly in a horizontal passing across the centre or slightly above it. A rod placed vertically against this of the board in the following directions shows the extreme warpings in its present dition to be as under:—

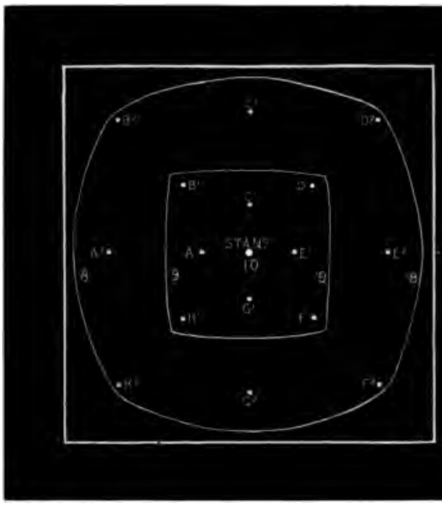
B2 to H2	..	..	.. 0·55 inch
B1 „ H1	..	..	.. 0·65 „
C2 „ G2	..	..	.. 0·50 „
D1 „ F1	..	..	.. 0·45 „
D2 „ F2	..	..	.. 0·40 „

TABLE II.

Results from Large Board (4 feet square).

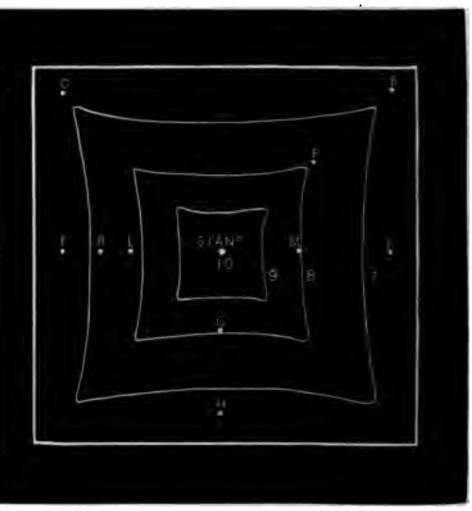
Hole.	Ratio of distance of Hole from Centre to distance from Centre to edge of Board in same direction.	First Series.			Second Series.		
		Mean Reading (all Observations).	Mean Reading for Group of Holes similarly situate on Board.	Mean Reading (using observations of Strong Winds only).	Mean Reading (all Observations).	Mean for Group.	Mean of Both Series.
A. 1	0·25	0·83	0·94	0·83	0·95	0·94	0·94
C. 1	·25	·95		·87	·89		
E. 1	·25	·99			·96		
G. 1	·25	·99			·95		
A. 2	0·75	0·73	0·83	0·70	0·91	0·86	0·845
C. 2	·75	·91		·70	·85		
E. 2	·75	·80			·77		
G. 2	·75	·89			·89		
B. 1	0·36	0·85	0·89	0·75	0·98	0·945	0·917
D. 1	·36	·94			·98		
F. 1	·36	·85			·91		
H. 1	·36	·91			·91		
B. 2	0·71	0·82	0·795	0·70	0·83	0·815	0·805
D. 2	·71	·80			·81		
F. 2	·71	·81			·77		
H. 2	·71	·75			·85		

Fig. III.



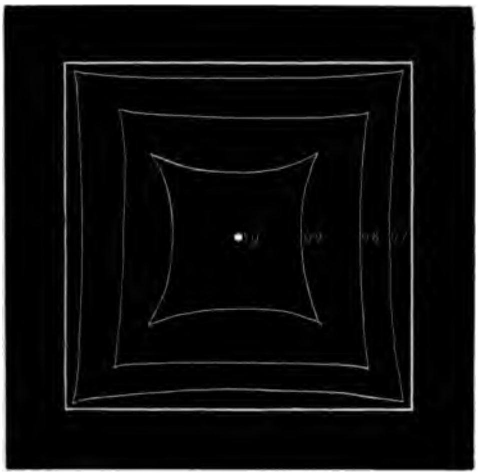
Map of Pressure Board 4-ft. square, showing position of holes and the distribution of pressure over the surface of the board indicated by the figures in Col. 8 of Table II.

Fig. IV.



Map of Pressure Board 1-ft. square, showing position of holes and the probable distribution of pressure upon the surface of the board indicated by the figures in Table I. (In drawing these lines the results from holes R., L. and C. were not used.)

FIG. V.



Map of Lines of Equal Pressure on a board 13-inches square, when the pressure at the centre is equivalent to 0·2 inch of water. The Nos. express the ratio of the pressure along each line to the central pressure.

DISCUSSION.

The PRESIDENT (Mr. Laughton), in inviting discussion, said that the paper was most opportune, as during the next month the attention of the Society would be turned a good deal to anemometry.

Mr. FIELD thought the paper a very interesting one, and that the subject required a great deal of study. He considered it most important that the board should be kept truly perpendicular to the direction of the wind during the experiments. He had found lately in testing air-meters that when the current of air was not quite perpendicular to the instrument, the registration of the instrument was affected. The authors should give the observed pressures of the wind and actual depressions of water in the tube, as he believed that the ratios only were given in the paper. It would also be well to give the velocities of the wind as recorded by a Robinson cup-anemometer for purposes of comparison.

Mr. MAWLEY considered that if we fully realised the fact that all our pressure anemometers are situated on some part of the rocky bed of a deep sea of air, the strongest currents of which are extremely variable both in strength and direction, it would be at once understood why it was that the small and thin metal plate, having a square and smooth surface with which we endeavoured to gauge the strength of these currents, so often failed to give results in which any great confidence could be placed. At the same time it would also become evident how greatly this subject of wind-pressures was beset with difficulties of all kinds ; as regards one of their difficulties, namely, that of keeping the pressure-plate at right angles to the wind in its combined lateral and upward or downward movement, he thought this might in some measure be overcome by employing a circular instead of a square opposing surface, and by having it slightly curved instead of flat—in other words, something in the form of a very shallow reflector.

Mr. WHIPPLE said we were much indebted to Messrs. Burton and Curtis for these experiments. He considered that they were not describing a new instrument, but only experimenting upon the distribution of pressure over flat surface. He inquired whether the levels in the gauges were read by means of a telescope at a distance ? If the observer stood immediately behind the board, his body would cause a disturbance of the air and introduce another resistance.

Mr. SYMONS thought that the paper should be regarded only as the register of a good idea. The tubes at the back were practically so many Lind's Anemometers. In the original anemometer made by Mr. Osler the pressure plate was much larger than is now generally used. As buildings greatly deflected the wind, he considered that anemometers should be placed on the tops of posts, pyramids or cones, so as to minimise this evil and be all similarly exposed.

Mr. LECKY thought that some experiments should be made by placing an aneroid at the front and back of the board.

Mr. WHIPPLE remarked that several experiments had been made in France with barometers on different sides of a tower during a gale of wind.

Mr. CURTIS said the apparatus was not intended to measure the absolute wind-pressure,but only the relative distribution of the pressure over the surface of the board. The inquiry was not complete, but, as had been intimated in the paper, it was intended to extend the experiments to boards of other shapes and sizes. He knew that the apparatus was not as perfect in all respects as it ought to have been, but under the circumstances this had been unavoidable, and therefore an attempt had been made to compensate for mechanical deficiencies by making constant and careful use of the "Dog-vane," and selecting only the most favourable moments for making the observations.

The PRESIDENT thought that the popular idea of upward and downward movements of the air is a very exaggerated one, and arises from the fact that observations are so commonly made on top of a house. Wind striking against a wall of a house or the face of a cliff is certainly deflected upwards, and at times with considerable violence; but he believed that under free conditions, the vertical component is extremely small.

THE HIGH ATMOSPHERIC PRESSURE IN THE MIDDLE OF JANUARY 1882. By H. SOWERBY WALLIS, F.M.S.

[Read February 15th, 1882.]

IN preparing this Paper, my object has been rather to put on record in an available form some of the more striking details of the high pressure of January, than to discuss any theories connected with it, or the causes which operated in producing it.

On January 7th, the barometer in London rose above 30 ins., and for the next few days was rather unsteady; but after each fall it rose higher than before, until, on the 12th, it was above 30·4 ins. From this time it was very equable, rising gradually. At 9 p.m. on the 14th the reading at Camden Square was 30·641 ins.; at 9 a.m. on the 16th 30·858 ins., the rise continuing gradually, and 30·900 ins. being reached just after 7 p.m. on the 16th; the pressure then remained nearly stationary for 6 hours, in the next 2 hours it rose ·02 in., again paused for 4 hours, and then rose steadily till at 11 a.m. on the 17th the reading was 30·952 ins.: after this there was a fall of ·035 in. in 4 hours, immediately followed by a rise of ·037 in. in 6 hours (30·954 ins., 9 p.m. 17th). The pressure was then again almost stationary for 10 hours, when a gradual rise commenced which continued for 4 hours, the absolute maximum occurring at 10.30 a.m. on the 18th, with a reading of 30·975 ins.

In the next 4 hours the pressure decreased ·035 in.; this was followed by a gradual recovery which lasted till 10 p.m. (18th), when the reading was 30·958 ins.; but the pressure again gave way, the fall continued, and at 9 a.m.

ı the 19th the reading was 30·931 ins. The pressure remained very equable, ıe fall being gradual, and it was not until about 5 p.m. on the 26th that it ıbsided below 30·5 ins.

The curves for Greenwich and Kew are remarkably accordant with that for amden Square, the maxima being respectively 30·975 ins. at 10 a.m. and 0·980 at 11 a.m. The curve for Stonyhurst also agrees much more closely ıan might have been expected, considering the distance which separates it ·om the other stations, but the pressure was not so great, readings being elow 30·9 ins. till 7 a.m. on the 18th; the maximum, which occurred at 1 a.m., was 30·94 ins.

ABLE of Hourly Values of Atmospheric Pressure (reduced to 32° and Sea-Level) on January 17th and 18th, 1882, at Kew, Greenwich, Camden Square, Geldeston and Stonyhurst.

'he values for Kew, Greenwich and Stonyhurst are from Photographic Barographs; those for Camden Square and Geldeston from eye-observations of Standard Barometers.

Hour.	17th.					18th.				
	Kew Observatory, Surrey.	Greenwich Observatory, Kent.	Camden Square, Middlesex.	Geldeston, Norfolk.	Stonyhurst Observatory, Lancashire.	Kew Observatory, Surrey.	Greenwich Observatory, Kent.	Camden Square, Middlesex.	Geldeston, Norfolk.	Stonyhurst Observatory, Lancashire.
	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
Midnight	30·91	30·906	30·903	..	..	30·94	30·945	30·946	..	30·88
1 a.m. ..	·90	·909	·904	..	30·84	·94	·940	·947	..	·88
2 „ ..	·91	·917	·915	..	·86	·94	·945	·949	..	·89
3 „ ..	·92	·918	·920	..	·86	·95	·950	·953	..	·89
4 „ ..	·92	·915	·915	..	·86	·95	·949	·954	..	·90
5 „ ..	·92	·918	·920	..	·86	·95	·949	·954	..	·88
6 „ ..	·92	·916	·916	..	·87	·94	·947	·948	..	·89
7 „ ..	.92	·918	·921	..	·88	·96	·946	·951	..	·89
8 „ ..	·94	·935	·940	30·898	·89	·97	·958	·960	30·921	·91
9 „ ..	·95	·935	·948	·907	·90	·98	·965	·970	·924	·92
10 „ ..	·95	·937	·943	·914	·89	·98	·970	·972	·919	·93
11 „ ..	·95	·941	·952	·902	·89	·98	·967	·972	·921	·94
Noon	·95	·941	·945	·903	·88	·97	·955	·966	·920	·92
1 p.m. ..	·94	·928	·933	·897	·87	·96	·939	·949	·908	·92
2 „ ..	·92	·917	.924	·879	·86	·95	·935	·942	·902	·91
3 „ ..	·92	·916	·917	·890	·86	·95	·934	·940	·903	·92
4 „ ..	·93	·918	·920	·895	·86	·95	·937	·945	·904	·92
5 „ ..	·93	·925	·924	·897	·86	·95	·937	·943	·904	·92
6 „ ..	·94	·935	·941	·894	·87	·95	·937	·943	·918	·92
7 „ ..	·95	·940	·946	·896	·87	·95	·944	·950	·926	·93
8 „ ..	·94	·942	·948	·904	·88	·95	·948	·954	·918	·92
9 „ ..	·95	·944	·954	·912	·88	·95	·937	·954	·917	·92
10 „ ..	·96	·946	·950	·912	·88	·95	·944	·958	·910	·92
11 „ ..	·95	·949	·946	30·908	·88	·95	30·945	·956	30·908	·92
Midnight	30·94	30·945	30·946	..	30·88	30·94	..	30·948	..	30·92

At this time an area of high pressure, which had had its centre over the ;ontinent for some days, had gradually moved westwards and reached our slands, the highest readings being in the southern half of England.

I regret having been unable to obtain more than the following short list of observations of the absolute maximum at British Stations, all of which occurred on the 18th :—

		ins.	
Sussex	St. Leonard's	30·990	10.23 to 10.37 a.m.
Gloucester	Cheltenham	·984	10.30 a.m.
Cheshire	Macclesfield	·984	10.30 a.m.
Sussex	Brighton	·983	10.30 a.m.
Surrey	Kew Observatory	·980	11 a.m.
Oxford	Banbury	·980	10.30 a.m.
Devon	Torquay, Babbacombe	·980	11 a.m.
Kent	Maidstone	·979	10 a.m.
Cornwall	Falmouth	·979	10 a.m.
Middlesex	Westminster, Great George Street	·978	10 a.m.
Kent	Tonbridge St. Mary's	·977	10.15 a.m.
Surrey	Croydon, Addiscombe	·976	10 to 11 a.m.
Kent	Greenwich Observatory	·975	10 a.m.
Middlesex	Camden Square	·975	10.30 a.m.
Surrey	Weybridge	·970	10 a.m.
Devon	Sidmouth	·968	11.15 a.m.
Lancashire	St. Michael's-on-Wyre	·945	11.15 a.m.
Lancashire	Stonyhurst Observatory	·94 *	11 a.m.
Dublin	Dublin	·935	10.30 p.m.
Norfolk	Geldeston	·924	9 a.m.

The maximum pressure occurred apparently over the whole of England about 10 or 11 a.m. on the 18th, and taking the average over the whole country was probably not more than ·005 in. higher than the 9 a.m. readings; the table of 9 a.m. observations will, therefore, show approximately the maximum pressure—from this it will be noticed that over the whole of the S, SW and South Midlands pressure was above 30·95 ins.; in the South-eastern counties averaging between 30·97 ins. and 30·98 ins., and in South Wales and the South-western counties between 30·96 ins. and 30·97 ins. In the Eastern counties, the North Midlands and North Wales the pressure averaged 30·92 ins. to 30·93 ins., and North of an imaginary line running from Lancaster to about the mouth of the Humber it was below 30·90 ins., the readings decreasing northwards, and being at Shields 30·84 ins. and at Alnwick 30·79 ins.

On the 17th and 19th the relative distribution of pressure was much the same as on the 18th, but the absolute values were rather lower.

The isobars of Western Europe on the 18th are irregular in shape, and appear to show an inclination of the central area of highest pressure to break up into two distinct regions.

At Camden Square during the last 23 years the atmospheric pressure has

* Read to the nearest hundredth of an inch from the barogram.

on only five occasions—besides that now under consideration—risen above 30·7 ins., viz. :—

			ins.
1859	Jan. 9	11.40 p.m.	30·830
1865	Dec. 15	9 p.m.	30·782
1867	Mar. 2	9 a.m.	30·788
1873	Feb. 18	11 a.m.	30·846
1879	Dec. 23	10 a.m.	30·813

and on only three of them above 30·8 ins. During last month, however, the pressure was continuously above 30·9 ins. for 67 hours, from 7 p.m. on the 16th to 2 p.m. on the 19th. It was above 30·8 ins. for 99 consecutive hours (4 days 3 hours), from 1 a.m. on the 16th to 4 a.m. on the 20th ; above 30·7 ins. for 6 days 6 hours, from 8 a.m. on the 15th to 2 p.m. on the 21st ; above 30·6 ins. for 7 days 17 hours, from 7 p.m. on the 14th to noon on the 22nd ; and above 30·5 ins. for 12 days 15 hours, from 2 a.m. on the 14th to 5 p.m. on the 26th.

I believe that pressures so high and of such long duration are without parallel, but have no means of verifying this opinion, as in nearly all cases of notes on high barometer readings the author has devoted his attention to the absolute height reached, almost to the exclusion of continuance of the phenomenon.

In a letter to the *Times* (January 18th) Mr. Symons quotes a reading at Greenwich Observatory on February 11th, 1849, which, reduced to sea-level, would be about 30·895 ins. (·080 in. lower than that of 1882), and adds :— "Rather more than a century since Sir George Shuckburgh (a remarkably accurate observer) is stated to have observed in 1778 'the barometer in London at 30·935 ins., which he believed to be the greatest elevation ever seen.' I do not know whence Belville quotes this statement, and it is not clear whether any corrections have been applied for temperature or for altitude. As the corrections would be of nearly equal amounts and of opposite signs, we shall, I think, be safe in assuming that 30·935 ins. was about the point reached in 1778." . . . . "Belville gives a table of extreme pressures at Greenwich (not at the Royal Observatory) from 1811 to 1848, and from it, applying all necessary corrections, I find that on January 9th, 1825, the sea-level pressure rose to 30·958 ins."

In 1835 also, on January 2nd, the pressure recorded by Belville reduced to sea-level is 30·908 ins.

In a leading article in *Nature* of January 26th, it is stated that readings of 31·046 ins. at 11 p.m. on January 8th, 1820, and of 31·007 ins. at 9 p.m. on February 24th, 1808, were observed at Gordon Castle, Banff, by Mr. James Roy, and it appears from the *Journal of the Scottish Meteorological Society* that these observations were made with a barometer with a wooden scale, which is believed to have been fairly correct, though it would not now be accepted as a standard instrument.

The reading of 1820 is also supported by the following values, which I

have reduced to sea-level as accurately as was possible without particulars of the exact position and external temperature :—

		ins.
Greenwich, Jan. 9th...	... ...	30·818
Leith, ,,	... ... 9 a.m.	31·065
Kinfauns, ,,	... ... 9 a.m.	31·054

M. Renou, in a note to the Paris Academy of Sciences, states that the maximum pressure at the Parc St. Maur was 786·92 mm. (30·981 ins.) at 10 a.m. on January 17th, and adds that during nearly a century only once has a pressure slightly exceeding this been recorded at the Paris Observatory. On February 6th, 1821, at 9 a.m. the height was 787·52 mm. (31·004 ins.), and it would appear that at Paris, with these two exceptions, the barometer has never exceeded 785·1 mm. (30·910 ins.) during two centuries.

In an article in the *Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie*, Dr. Hann says, " The maximum pressure of the 16th at 10 a.m., 768·3 mm. (30·249 ins.), or 787·9 mm. (31·020 ins.) at sea-level, is probably the highest in Vienna since 1775, for the sea-level pressure of 788·3 mm. (31·036 ins.) on February 8th, 1821, cannot be relied upon as within ·01 in. or ·02 in. of the truth. With the exception of that occasion the previous maximum sea-level pressure was only 785·6 mm. (30·930 ins.) on the 9th of January, 1859."

Dr. Hann does not state his reason for doubting the accuracy of the reading of February 8th, 1821, and this does not appear unreasonable if it be compared with Paris, where the maximum was 31·004 ins. on the 6th (only ·022 in. lower), and besides, there was a well-developed area of high pressure at the time, for a height of 30·826 ins. was recorded at Dantzig at 10 p.m. on the 6th, 30·90 ins. at Prague at 7.30 a.m. on the 8th, and 30·888 ins. at Greenwich on the 6th.

I have extracted from the Continental Weather Reports the highest pressures registered at the regular hours of observation at some of the principal towns between the 15th and 19th of January inclusive; these are of course not absolute maxima, but they are probably very near to it. They were as follows :—

	ins.		
Berne	31·012	7 a.m.	17th.
Hamburg...	30·969	8 p.m.	16th.
Brussels	30·961	8 a.m.	18th.
Berlin	30·945	8 a.m.	16th.
Copenhagen	30·922	8 a.m. & 6 p.m.	16th.
Madrid	30·902	7 a.m.	17th.
Munich	30·886	8 p.m.	16th.
Rome	30·788	7 a.m.	16th.
Lisbon	30·650	8 a.m.	17th & 18th.

I have also added a table of all the readings above 787 mm. (30·985 ins.) given in the French and German weather reports during the same time (15th to 19th inclusive), nineteen of which are above 31 ins.

TABLE showing the Atmospheric Pressure at 32°, and at Sea-Level at various places in the British Isles, January 17th, 18th and 19th, 1882.

County.	Station.	17th, 9 a.m.	18th, 9 a.m.	19th, 9 a.m.	*Highest observed Reading.	
					Values.	*Time.
		Ins.	Ins.	Ins.	Ins.	
Middlesex	Regent's Park	30·946	30·954	30·916	30·954	9 a.m.
,,	Camden Square	·948	·970	·931	·975	10.30 a.m.
,,	Isleworth	·940	·978	·914	·978	9 ,,
Surrey	Norwood	·940	·970	·929	·970	9 ,,
,,	Addiscombe	·948	·972	·918	**·976**	10 to 11 ,,
,,	Cranleigh	·882	·893	·860	·893	9 ,,
Kent	Beckenham, Foxgrove	·931	·960	·906	·972	11.15 ,,
,,	,,	·929	·961	..	·961	9 ,,
,,	Tunbridge	·933	·967	·921	**·977**	10.15 ,,
,,	Tunbridge Wells	·934	·968	·922	·968	9 ,,
Sussex	Brighton	·957	·978	..	**·983**	10.30 ,,
,,	St. Leonard's	·950	·974	·927	**30·990**	10.23 to 10.37 a.m.
,,	Worthing	·917	·957	·916	31·051 ?	9 p.m.
,,	Crowborough	·943	·967	·926	30·967	9 a.m.
Hants	South Bourne	·943	·979	·927	·979	9 ,,
,,	Bournemouth	·892	·910	·860	·935	8 p.m.
,,	Portsmouth	·953	·986	·925	·986	9 a.m.
,,	Harestock	·960	·986	·929	·986	9 ,,
,,	Strathfield Turgiss	·938	·967	·907	·967	9 ,,
Herts	Watford	·953	·985	·934	·985	9 ,,
Oxford	Banbury	·896	·972	·921	**·980**	10.30 ,,
Suffolk	Lowestoft	·904	·918	·890	·918	9 ,,
,,	Somerleyton	·901	·883	·893	·907	3 p.m.
Norfolk	Hillington	·904	·930	·900	·930	9 a.m.
Wilts	Marlborough	·951	·983	·927	·983	9 ,,
Devon	Totnes	·926	·987	·922	·987	9 ,,
,,	Babbacombe	·923	·976	·911	**·980**	11 ,,
,,	Teignmouth	·914	·965	·883	·965	9 ,,
,,	Sidmouth	·916	·960	..	**·968**	11.15 ,,
,,	Dartmoor	..	·981	·927	·981	9 ,,
Somerset	Downside	·944	·972	·916	·972	9 ,,
Gloucester	Bristol	·944	·972	·916	·972	9 ,,
,,	Cheltenham	·939	·976	·927	**·984**	10.30 ,,
Hereford	Ross	·926	·960	·903	·960	9 ,,
,,	Burghill	·910	·943	·879	·943	9 ,,
Shropshire	Leaton	·926	·954	·889	·954	9 ,,
Stafford	Cheadle	·923	·958	·917	·958	9 ,,
Warwick	Birmingham	·908	·969	·945	·969	9 ,,
,,	Kenilworth	·918	·946	·912	·946	9 ,,
Leicester	Loughborough	·909	·941	·918	·941	9 ,,
Notts	Hodsock	·883	·918	·903	·918	9 ,,
,,	Strelley	·904	·940	·931	·940	9 ,,
,,	Belper	·905	·938	·921	·938	9 ,,
Cheshire	Macclesfield	·923	·933	·914	**·945**	4 p.m.
Lancashire	Blackburn	·869	·890	·865	·890	9 a.m.
,,	Blackpool	·894	·937	·908	·937	9 ,,
York	Wakefield	·906	·886	·894	·908	9 p.m.
,,	Scarborough	·826	·869	·864	·869	9 a.m.
Northumberland	Alnwick	·743	·792	·830	·841	9 p.m.
,,	Cramlington	·788	·853	·865	....	....
Cumberland	Cockermouth	·848	·889	·876	·889	9 a.m.
,,	Scaleby	·844	·891	·882	·891	9 a.m. and 9 p.m.
Glamorgan	Cardiff	·861	·903	·848	·903	9 a.m.
Carmarthen	Carmarthen	·928	·969	·918	·969	9 ,,
Montgomery	Churchstoke	·939	·974	·908	·974	9 ,,
Denbigh	Wrexham	·883	·909	·884	·909	9 ,,
Carnarvon	Llandudno	·888	·926	·904	·926	9 ,,
Orkney	Sandwick	·573	·697	·662	·710	9 p.m.
Dublin	Dublin	·863	·931	·886	·936	9 ,,
,,	,, Fitzwilliam Sq.	·864	·929	·895	**·935**	10.30 ,,
Kerry	Killarney	30·844	30·931	30·887	30·956	11 a.m.

* These readings all occurred on the 18th, and those printed in large type represent the absolute maximum pressure.

TABLE of all Readings of Sea-Level Pressure above 787 mm. (30·985 ins.) printed in the French and German Daily Weather Reports for the 15th to the 18th (inclusive) of January, 1882.

Converted to English inches.

Station.	Pressure.	Time.	Date.	Station.	Pressure.	Time.	Date.
	Ins.				Ins.		
Wilna	31·071	7 a.m.	16th	Belfort	31·004	7 a.m.	17th
Kiew	·056	7 a.m.	16th	Konigsberg	31·001	9 p.m.	15th
Warsaw	·056	9 p.m.	15th	Thorn	30·997	8 a.m.	15th
Cracow	·052	6 p.m.	15th	Lemberg	·997	6 p.m.	15th
Prague	·036	7 a.m.	16th	Wilna	·993	7 a.m.	15th
Neufahrwasser..	·024	8 a.m.	15th	Memel	·993	2 p.m.	15th
Konigsberg	·024	8 a.m.	15th	Vienna	·993	6 p.m.	15th
Lemberg	·024	7 a.m.	15th	Breslau	·993	10 p.m.	15th
Neufahrwasser..	·024	2 p.m.	15th	Swinemunde ..	·993	8 a.m.	16th
Cracow	·024	7 a.m.	16th	Berne..	·993	6 p.m.	16th
Prague	·020	6 p.m.	15th	Prague	·989	7 a.m.	15th
Warsaw	·020	7 a.m.	16th	Hermannstadt..	·989	7 a.m.	15th
Cracow	·016	7 a.m.	15th	Berne	·989	7 a.m.	16th
Berne..........	·012	7 a.m.	17th	Vienna	·985	7 a.m.	16th
Breslau	·008	8 a.m.	16th	Besançon	·985	7 a.m.	17th
Prague	·008	6 p.m.	16th	Wilna	30·985	9 p.m.	15th
Neufahrwasser	31·004	8 p.m.	15th				

DISCUSSION.

The PRESIDENT (Mr. Laughton) said that it was fortunate that the facts of this very remarkably high pressure had been thus collected together into a permanent record by such an accurate and painstaking inquirer as Mr. Wallis. He hoped the next step would be for some one to investigate the conditions under which it had occurred.

Capt. TOYNBEE remarked that during the prevalence of the high pressure he had noticed that in the South of France (under the high pressure) the temperature had been low, whilst in Norway, which was under the influence of areas of low pressure, it had been high. He should be glad to know whether the motion of cirrus clouds during this time supported the theory which states that upper currents of air flow from areas of low pressure towards areas of high pressure, thereby keeping up the supply of air in the area of high pressure by a downward current, and preventing the fall of the barometer, which would otherwise take place owing to the flow of surface wind from the high towards the low pressure. The long continuance of this high pressure in one place was, he hoped, favourable for such observations.

Mr. SCOTT remarked that mild weather had prevailed during the recent period of high pressure, which was not generally the case, as such conditions were usually attended with severe frost.

Mr. SYMONS thought that this period of high pressure would, on account of its uniformity, prove one of the best means of ascertaining the errors of barometers, of the accuracy of the observers, and of the correctness of the assumed altitudes. He considered that the pressure of 31·046 ins. at 11 p.m. on January 8th, 1820, at Gordon Castle, was correct, as it was confirmed by the observations at Kinfauns and Leith. He thought that the fog had prevented most Londoners from making observations of cirrus.

Mr. WHIPPLE said this period was remarkable for the absence of wind, and the air was consequently in a state of stagnation. At the Kew Observatory, on one day, January 22nd, only 20 miles of wind were registered as passing over in the 24 hours; he never saw the anemometer so stationary before, there was therefore no possibility of the fog being cleared away. He thought that to some extent a re-consideration of the question of correcting barometers for height

might produce a higher degree of uniformity in the readings than that now attained.

Mr EATON believed it might be interesting to the Fellows to have some further particulars of the great barometric elevation of January 1820, which was undoubtedly the highest on record in the British Isles, although not of long duration. He had prepared the annexed comparative table from various sources, the localities being arranged according to latitude from north to south, the direction in which the area of highest pressure seemed to have moved.

BAROMETER AT 32° REDUCED TO SEA-LEVEL.

1820. January.	Gordon Castle, Banffshire.†	Kinfauns, Perth.*	Hermitage Hill, Leith.*	Royal Society, London.
	ins.	ins.	ins.	ins.
7th, 8 a.m.	—	—	—	30·358
9 "	—	—	30·359	—
10 "	—	30·397	—	—
2 p.m.	—	—	—	30·517
10 "	—	30·711	30·730	—
8th, 8 a.m.	—	—	—	30·662
9 "	—	—	30·830	—
10 "	—	30·885	—	—
Noon	—	30·896	—	—
2 p.m.	—	30·909	—	30·684
4 "	—	30·931	—	—
6 "	—	30·949	—	—
7 "	—	30·969	—	—
9 "	—	30·993	—	—
10 "	—	31·002	30·975	—
11 "	31·046	31·014	—	—
9th, 8 a.m.	—	—	—	30·832
9 "	—	31·056	31·050	—
10 "	—	31·045	—	—
2 p.m.	—	—	—	30·779
10 "	—	30·873	30·820	—
10th, 8 a.m.	—	—	—	30·663
9 "	—	—	30·720	—
2 p.m.	—	—	—	30·582
10 "	—	—	30·399	—
11th, 8 a.m.	—	—	—	30·126
9 "	—	—	30·104	—

The absolute maximum pressure on this occasion probably occurred at an earlier hour than 9 a.m. on the 9th in Perthshire, and so escaped observation, and there was also reason to believe that a still higher pressure than 31·046 ins. was experienced at Gordon Castle. There was no record of the atmospheric pressure in London having been so great as in the month of January last; and a careful search showed that for the last 108 years at least, and probably many more, the barometric readings had only exceeded 30·9 ins. on two occasions, namely, in December 1778 and in January 1825. At the former date the Royal Society register indicated a corrected sea-level pressure on the 26th at 8 a.m. of 30·880 ins., increasing to 30·918 ins. at 2 p.m.; on the following day at 8 a.m. it was 30·852 ins.; and Mr. Belville stated in his *Manual of the Barometer*, p. 17, "It is recorded that Sir George Shuckburgh, in 1778, in London, observed the barometer at 30·935 ins., which he believed to be the greatest elevation ever seen;" and this no doubt referred to the same date.

The extremely high pressure in January 1825 was of longer duration than in December 1778, and must have embraced a wider area. The corrected sea-level readings, calculated from the Royal Society register at Somerset House, were:—

† *Journal of the Scottish Meteorological Society*, New Series, Vol. V., p. 63.
* "Account of the remarkable Depression of the Thermometer, and Rise of the Barometer, in January 1820." *Edinburgh Philosophical Journal*, Vol. II., p. 335.

8th, 3 p.m. 30·817 ins.; 9th, 9 a.m. 30·922 ins., 3 p.m. 30·913 ins.; 10th, 9 a.m. 30·914 ins., 3 p.m. 30·884 ins. Other readings recorded on the morning of the 9th were, Kinfauns Castle, 10 a.m. 30·925 ins.; New Malton, Yorkshire, highest 30·927 ins., and at the Royal Observatory, Greenwich, 10 a.m. 30·943 ins.

Mr. WALLIS thought that the suggestion of the President, that the conditions under which the phenomena had occurred should be thoroughly investigated, was an important one. He had only attempted to collect a few statistics while the matter was fresh in the minds of the observers, but there could be no doubt that the atmospheric conditions during the whole month were exceptionally abnormal, the high pressure being accompanied by high temperature instead of by cold, as was generally the case, and by a stillness of the air even more marked than usual. He believed that if the whole subject of the general character of the weather and the instrumental results were exhaustively treated, it would in all probability give a greater insight into the factors which govern the weather than could be obtained from the study of any number of normal months.

In conclusion, he wished to express his thanks to the Fellows of the Society who had so courteously complied with his request for copies of their observations.

PROCEEDINGS AT THE MEETINGS OF THE SOCIETY.

JANUARY 18th, 1882.

Annual General Meeting.

GEORGE JAMES SYMONS, F.R.S., President, in the Chair.

Mr. R. H. CURTIS and Mr. T. L. K. EDGE were appointed Scrutineers of the Ballot for Officers and Council.

Dr. TRIPE read the Report of the Council and the Financial Statement for the past year. (p. 110.)

It was proposed by the PRESIDENT, seconded by Dr. TRIPE, and resolved:—"That the Report of the Council be received and adopted, and printed in th Society's Journal."

It was proposed by Mr. LAUGHTON, seconded by Mr. MAWLEY, and resolve —"That the best thanks of the Meteorological Society be communicated to Council of the Institution of Civil Engineers for having granted the Society permission to hold its Meetings in the rooms of the Institution."

It was proposed by Capt. TOYNBEE, seconded by Mr. DYASON, and resol —"That the thanks of the Society be given to the Officers and other Mer of the Council for their services during the year."

...osed by Dr. MARCET, seconded by Mr. PEARSE, and resol... ...ciety be given to the Standing Committees and

The PRESIDENT then delivered his Address. (p. 101.)

It was proposed by Mr. EATON, seconded by Mr. INWARDS, and resolved:—"That the thanks of the Society be given to the President for the ability and courtesy displayed by him in the Chair during his term of office, and for his Address, and that he be requested to allow it to be printed in the Quarterly Journal of the Society."

The Scrutineers declared the following gentlemen to be Officers and Council for the ensuing year:—

President.

JOHN KNOX LAUGHTON, M.A., F.R.A.S., F.R.G.S.

Vice-Presidents.

WILLIAM ELLIS, F.R.A.S.
ROGERS FIELD, B.A., M.Inst.C.E.
JOSEPH HENRY GILBERT, Ph.D., F.R.S., F.C.S.
BALDWIN LATHAM, M.Inst.C.E., F.G.S.

Treasurer.

HENRY PERIGAL, F.R.A.S.

Trustees.

HON. FRANCIS ALBERT ROLLO RUSSELL, M.A.
STEPHEN WILLIAM SILVER, F.R.G.S.

Secretaries.

GEORGE JAMES SYMONS, F.R.S.
JOHN WILLIAM TRIPE, M.D., M.R.C.P.E.

Foreign Secretary.

ROBERT HENRY SCOTT, M.A., F.R.S., F.G.S.

Council.

EDMUND DOUGLAS ARCHIBALD, M.A.
ARTHUR BREWIN, F.R.A.S.
JOHN SANFORD DYASON, F.R.G.S.
EDWARD ERNEST DYMOND, J.P.
HENRY STORKS EATON, M.A.
CHARLES HARDING.
ROBERT JOHN LECKY, F.R.A.S.
WILLIAM MARCET, M.D., F.R.S., F.C.S.
EDWARD MAWLEY, F.R.H.S.
RICHARD STRACHAN.
GEORGE MATHEWS WHIPPLE, B.Sc., F.R.A.S.
CHARLES THEODORE WILLIAMS, M.A., M.D., F.R.C.P.

Mr. SYMONS having left the chair, it was taken by the newly elected President, Mr. LAUGHTON, who thanked the Fellows for the honour they had done him in electing him to that office.

FEBRUARY 15th, 1882.

Ordinary Meeting.

JOHN KNOX LAUGHTON, M.A., F.R.A.S., F.R.G.S., President, in the Chair.

WILLIAM ARONSBERG, J.P., Holywell House, Oxford Road, Manchester;
WILLIAM GOUGH BIRCHBY, Glendower Terrace, Monton Green, Eccles;

JOHN RAND CAPRON, F.R.A.S., Guildown, Guildford;
PHILIP CROWLEY, F.Z.S., Waddon House, Croydon;
WILLIAM WOOD CULCHETH, M.Inst.C.E.;
DAVID CUNNINGHAM, M.Inst.C.E., F.S.S., Harbour Chambers, Dundee;
STEPHEN CUSHING, Hindringham, Norfolk;
WILLIAM NELSON GREENWOOD, Glasson Dock, Lancaster;
EDWARD KITTO, 10 Trelawney Road, Falmouth;
JAMES MANSERGH, M.Inst.C.E., 3 Westminster Chambers, S.W.;
GEORGE OLIVER, M.D., West End Park, Harrogate;
HENRY SELBY HELE SHAW, Assoc.M.Inst.C.E., 2 Pembroke Vale, Clifton, Bristol;
GEORGE WILSON STEVENSON, M.Inst.C.E., F.G.S., 38 Parliament St., S.W.; and
WILLIAM HENRY TYNDALL, Morlands, Oxford Road, Redhill,

were balloted for and duly elected Fellows of the Society.

The following Papers were read, viz.:—

"NOTES OF EXPERIMENTS ON THE DISTRIBUTION OF PRESSURE UPON FLAT SURFACES PERPENDICULARLY EXPOSED TO THE WIND." By R. H. CURTIS, F.M.S., and C. E. BURTON, B.A., F.R.A.S. (p. 139.)

"THE PRINCIPLE OF NEW ZEALAND WEATHER FORECASTS." By Commander R. A. EDWIN, R.N., F.M.S. (Abstract.)

New Zealand Forecasts are framed on the following hypotheses:—A. All winds are rotatory. B. There are two classes of aerial circulation. 1. Systems of elevation, readings of 30·10 ins. and upwards. 2. Systems of depression, readings of 30·00 ins. and downwards. Readings between 30·00 ins. and 30·10 ins. are considered as intermediate between depressions and elevations. The larger areas may contain more than one sub-area, much as a contoured map shows several peaks or valleys, enclosed by a single closed contour line. Both systems are elliptic, as long as they have no progressive movement. All isobars are drawn strictly parallel to the wind. When movement occurs in either case the area ceases to be truly elliptic, and the resistance experienced compresses the anterior portion, and delays its progress, especially if the system meets a mountain range. This renders the gradients steeper in the compressed parts of the system. The passage of a system over the range has the effect of retarding its rear portion while the front will be compressed by the resistance of the air, the gradients are therefore always steepest in front.

As there are several centres to each great aerial system, gale may succeed gale for a length of time without any complete restoration of pressure to its normal condition, and sudden changes of wind and weather may ensue without any erratic movements of the depressions.

Isobars must follow wind in all its shifts, for every change of wind must have a corresponding modification of pressure to account for it, and the changes of pressure in progress, whether increase or decrease, must be taken account of in drawing the map or framing the forecasts.

The paper was illustrated by diagrams of complex cyclonic and anticyclonic systems, and further by a map in which Commander Edwin has combined the observations taken on board H.M.S. 'Cormorant' and the S.S. 'Penguin' at sea, with those taken on shore, and represents his idea of the sequence of weather in New Zealand in the early part of March 1880.

DISCUSSION.

Mr. SCOTT remarked that Commander Edwin, in making allowance for the wind in the drawing of isobars, agreed with the practice of Mr. Rundell and others, who considered that there must be always a deviation of the isobar to account for every local deviation in the wind direction. If Commander Edwin's idea of the isobars being pressed closer together when a depression approached the land were applied to Europe, it would mean that in all our storms the SE wind was stronger than the NW, which was not the case. As regards the alleged more

rapid motion of the storms of the Southern Hemisphere, it appeared to him that Dr. Köppen's recent paper in the *Mittheilungen der Geog. Gesellschaft*, Hamburg, 1880, on the paths of barometrical minima over the Atlantic, suggested a possible explanation. Dr. Köppen holds that the motion of storms is mainly regulated by the upper currents. Now the rate of vertical decrease of pressure in the atmosphere is slower at the equator than in high north latitudes. This gives a gradient towards the pole in the upper strata, and induces a motion from W. in those strata, and this carries the depressions with it. Now in the Temperate Zone of the Southern Hemisphere, as the pressure at sea-level is much less than it is in corresponding latitudes in the Northern Hemisphere, it may be supposed that this upper level gradient will be steeper, and, therefore, the motion from the westward of the upper currents and consequently of the depressions would be more rapid.

Capt. Toynbee said this paper seemed to imply that a cyclonic wind-system is a body of air circulating and at the same time advancing over the earth's surface, also that it meets with a certain amount of resistance from objects lying in its track. Another theory supposes that there is no transfer of air along the line in which the cyclone is moving, but that its apparent progress is the result of successive reformations in front and fillings up in the rear. Also that the direction of the track and the speed of the apparent progress depend on the nature and disposition of the surrounding air, as to its suitability for the formation and filling up of the areas of low barometric pressure. It would be well if meteorologists would endeavour to solve this question, which is of vital importance to meteorology.

Mr. Whipple said that Commander Edwin gave no indication whatever of the results of these forecasts, or the amount of success he had attained. Prof. Loomis in his twelfth paper stated that the average rate of motion of storm-centres in Eastern America was greater than in Europe, and also higher over land than over sea.

Mr. Mawley said that he had some reason to believe that there was a sufficiently regular sequence in the weather changes that took place in this country to warrant us at all events in assuming that certain precise conditions prevailing on any one day were likely to be followed on the next by a similar state of the weather to that which had succeeded the same precise conditions at any previous date. He, therefore, suggested that in the first instance a careful classification should be made of a large number of daily Weather Charts, regard being at the same time paid to the season of the year. When this had once been accomplished it would only be necessary as soon as the weather map on any evening had been drawn to select the classified chart most resembling it, and to issue as the forecast for the next day a description of the weather that was found to have prevailed on the day following the one on which the selected chart had been made. The degree of correctness of such a prediction would, he thought, be found to vary in proportion to the amount of similarity between any two maps. A still closer approximation to the truth could of course be obtained by fastening together the two weather maps of each day and founding the forecast upon the similarity of these two maps with those drawn at any previous date of the same season of the year. Where the resemblance was not found to be very great, and indeed in all other cases as well, but more particularly in these, he considered it would be advisable to bear in mind that our changes of weather seldom came upon us with any very great suddenness, and therefore the conditions recently prevailing were in by far the greater number of instances likely to be succeeded by weather of a more or less similar character.

"The High Atmospheric Pressure in the middle of January 1882." By H. Sowerby Wallis, F.M.S. (p. 146.)

The Electrical Thermometer, kindly lent by Messrs. Siemens Brothers & Co., for observing the temperature of the air at the summit of Boston Church Tower, was exhibited.

RECENT PUBLICATIONS.

ANNUAIRE DE LA SOCIÉTÉ MÉTÉOROLOGIQUE DE FRANCE. 29me Année, 1881. 2nd Trimestre. 4to.

Contains :—Sur les périodes diurnes de la température et de la pression atmosphérique, par Prof. D. Ragona (7 pp.).—Baromètre et thermomètre enregistreurs de MM. Richard frères, par A. Angot (2 pp.).—Sur les enregistreurs de l'électricité atmosphérique et du magnétisme terrestre, par E. Mascart (5 pp.). —Sur les séismes ou tremblements de terre, par A. d'Abbadie (5 pp.).—Sur les crues de la Seine pendant l'hiver de 1881, par G. Lemoine (4 pp.).—Etudes sur la nébulosité en Russie, par A. Woeikof (11 pp.).—Le climat de Paris, par E. Renou (3 pp.).—Description du thermomètre maxima et minima à tiges ou à lames métalliques droites, par M. Tremeschini (2 pp.).

COMMUNICATIONS FROM THE INTERNATIONAL POLAR COMMISSION. Parts I.-II. 4to. 1882.

The International Polar Commission has resolved to issue a special publication, to appear in irregular numbers, in order to ensure the rapid and continuous dissemination of intelligence relating to the International Polar Expeditions projected by the late Lieut. Weyprecht. The publication, of which the above are the first two parts, will contain the resolutions, instructions, and reports of the Commission, and, in due time, reports of the progress and condition of the observing parties, as well as some preliminary results of their work. Contributions are received in any of the three languages—French, German, or English, and are printed in their original language.

DIE ERGEBNISSE DER NIEDERSCHLAGS-BEOBACHTUNGEN IN LEIPZIG UND AN EINIGEN ANDEREN SÄCHSISCHEN STATIONEN VON 1864-1881, VON A. VON DANCKELMAN, DR. PHIL. 4to. 1882 (16 pp.).

This is divided in two parts : (1) on the Rainfall observations at the Leipzig Observatory, 1861-1881 ; and (2) Results of the Rainfall observations at some of the Saxon stations.

INDIAN METEOROLOGICAL MEMOIRS: being occasional Discussions and Compilations of Meteorological Data relating to INDIA AND THE NEIGHBOURING COUNTRIES. Published under the direction of HENRY F. BLANFORD, F.R.S., Meteorological Reporter to the Government of India. Vol. I. Part VI. 4to. 1881.

Contains :—The Meteorology of the North-West Himálaya, by S. A. Hill, B.Sc. (50 pp.).

MEMORIE DELLA R. ACCADEMIA DI SCIENZE, LETTERE ED ARTI DI MODENA. Sezione di Scienze. Vol. I. Ser. II. 4to. 1882.

Contains a paper by Prof. D. Ragona on the Summer of 1881. (33 pp.).

PROCEEDINGS OF THE ROYAL SOCIETY. Vol. XXXIII. Nos. 217 and 218. 1882. 8vo.

Contains :—On the constituent of the atmosphere which absorbs radiant heat, by S. A. Hill, B.Sc. (11 pp.).—On measuring the relative thermal intensity of the Sun, and on a self-registering instrument for that purpose, by E. Frankland, D.C.L., F.R.S. (10 pp.).

PROCEEDINGS OF THE ROYAL SOCIETY OF EDINBURGH. Vol. XI. Nos. 108-109. Session 1880-81. 8vo.

Contains :—On Dust, Fogs, and Clouds, by John Aitken. 2 papers (9 pp.). From experiments, the author shows : 1, that whenever water vapour condenses in the atmosphere it always does so on some solid nucleus ; 2, that dust particles in the air form the nuclei on which the vapour condenses ; 3, that if there were no dust there would be no fogs, no clouds, no mists, and probably no rain, and

that the supersaturated air would convert every object on the surface of the earth into a condenser on which it would deposit.—On the motion of a Storm in an easterly direction being only possible as a circular atmospheric wave, by R. Tennent (3 pp.).

Report of Observations of Injurious Insects during the year 1881, with methods of Prevention and Remedy, and Special Report on Turnip Fly. By Eleanor A. Ormerod, F.M.S. 111 pp. 8vo. 1882.

The year 1881 was a season of severe insect attack, especially to root crops, and some kinds of forest trees. Turnip "Fly" attack was little short of a scourge over a large part of England and Scotland, and in the north of Scotland, where fly was comparatively absent, a small weevil bore down on the crop in its place, whilst in the south of Scotland it devastated in addition in a part of the attacked area. Miss Ormerod estimates the loss caused by the Turnip Fly on mere seed and resowing in 22 English and 11 Scottish counties to be:—for seed alone £75,592 16s.; for one resowing, including seed and cultivation, at the rate of 15s. per acre, £503,952; the same at the rate of 20s. per acre, £671,936.

Report of the Meteorological Council to the Royal Society, for the year ending 31st of March, 1881. 8vo. 1882. 131 pp.

In addition to the report on the work of the office, this contains reports or notes on the following subjects:—1. The Working of the Harmonic Analyser; 2. On Fogs; 3. On Hygrometry and Evaporation; 4. On Cirrus Observations; 5. On the Photo-Nephograph; 6. On the British Rainfall Means; 7. Method followed in the extraction of data from Ships' Logs; 8. Inspectors' Reports; 9. Method of dealing with Telegraphic Weather Intelligence; 10. Methods followed in dealing with Meteorological Returns from Land Stations in the United Kingdom.

Sitzungsberichte der kaiserlichen Akademie der Wissenschaften. Bande LXXXIV.—V. Dec. 1881—Jänn 1882 Hefte. 8vo.

Contains two Papers by Dr. J. Hann, viz.: (1.) Ueber die monatlichen und jährlichen Temperaturschwankungen in Oesterreich-Ungarn (73 pp.); and (2.) Ueber die Temperatur der südlichen Hemisphäre (24 pp.).

Sitzungsberichte der konigl. Böhm. Gesellschaft der Wissenschaften. 8vo. 1882.

Contains:—Ueber den täglichen Gang des Regenfalles, von Prof. Dr. F. Augustin (30 pp. with 2 plates).

Symons's Monthly Meteorological Magazine. February to April 1882, Nos. 193-195. 8vo.

Contains:—Meteorological Bibliography (3 pp.).—Barometric and thermometric extremes in January 1882 (2 pp.).—Climatological data for the British Empire (5 pp.).—Temperature observations at Boston, Lincoln (2 pp.).—The late winter and the coming summer (2 pp.).—The Anemometer Exhibition (8 pp.).

The Weather of 1881 as observed in the Neighbourhood of London, and compared in all respects with that of an average year. By Edward Mawley, F.M.S., F.R.H.S. With Tables of Daily Observations and a Diagram. 72 pp. 8vo. 1882.

This gives a summary of the weather at Addiscombe, near Croydon, for each month, together with tables of daily observations, which are compared with the Greenwich averages of 20 years. The author sets forth the more prominent features of the year as follows:—The great frost, gale, and snow of January; the stormy and continuous NE winds of the spring; the succession of 5 dry months (March-July); the rare incident of a ground frost in June, followed by a day in July hotter than any of which there is any reliable record. The two succeeding months of harvest were rendered disastrous, the first through great cold and wetness, and the latter by its frequent rains, humid atmosphere and sunless skies. October, which will certainly rank as one of the coldest ever known, brought with it a long and destructive westerly gale; and with November, which was almost as exceptionally mild, came another of still greater violence; while the

closing month of the year proved to be one of many storms and much rough weather.

VEGA-EXPEDITIONES VETENSKAPLIGA IAKTTAGELSER. Vol. I. 8vo. 1882.

Contains :—Observations Météorologiques faites par l'Expédition de la Vega du cap Nord à Yokohama par le Détroit de Behring. Reduites par H. Hildebrand Hildebrandsson. 101 pp. with 4 plates. Throughout the whole of the voyage the observations were made six times a day, as well as while wintering at Pitlekaïe during the months of October 1878, and April to July 1879, but at the beginning of November till the end of March, they were made hourly. The observations are divided into two parts : (1) Observations at Pitlekaïe from October 1st, 1878, to July 17th, 1879, and (2) Observations during the voyage from the port of Maasö near the North Cape to Pitlekaïe and from thence to Yokohama.

ZEITSCHRIFT DER ÖSTERREICHISCHEN GESELLSCHAFT FÜR METEOROLOGIE. Redigirt von Dr. J. HANN. XVII. Band. February-April 1882. 8vo.

Ueber die Regenmenge in Breslau und einige neuere Versuche, die Abnahme derselben mit der Höhe betreffend, von J. G. Galle (4 pp.).—Leistungen der Registrirapparate mit Laufgewicht, von Dr. A. Sprung (4 pp.).—Bemerkungen über die verticale Vertheilung des Luftdruckes, von Dr. W. Köppen (13 pp.).—Thermische Vegetationsconstanten ; Sonnen- und Schattentemperaturen, von Prof. H. Hoffmann (10 pp.).—Ueber die Messung der Temperatur mit Hülfe des Quecksilberthermometers, von M. Pernet (5 pp.).—Die Niveauflächen der Cyklonen, von H. Januschke (5 pp.).

QUARTERLY JOURNAL

OF

THE METEOROLOGICAL SOCIETY.

Vol. VIII. No. 43.

Historical Sketch of Anemometry and Anemometers. By J. K. Laughton, M.A., F.R.G.S., President.

[Read March 15th, 1882.]

It is probable, and indeed almost certain, that the earliest attempts at gauging wind-force were made by sailors; to a landsman, the cold, the heat, the dryness or moisture of a wind is commonly its most noticeable feature; not so to the sailor; and we may therefore assume that from the very dawn of navigation sailors estimated, and in some technical language expressed, the force as well as the direction of the wind. When poetry could get the length of such a description as—

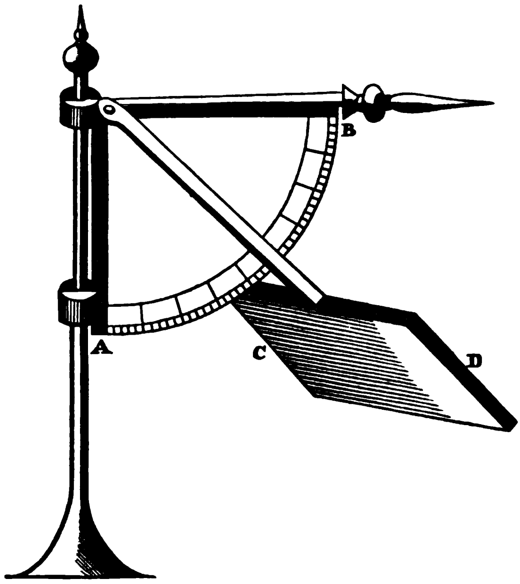
"Una Eurusque Notusque ruunt, creberque procellis
Africus, et vastos volvunt ad litora fluctus;"

we may be quite sure that seafaring men had their own names for a 'gale,' a 'squall,' a 'capful of wind,' or a 'light breeze.' And so, in fact, they always have had, down to our own times, and quite irrespective of any system of accurate measurement. The most modern and most exact form of this is the Beaufort scale, which to many may seem but a manner of guessing, but which to a sailor on board his ship had, at the time it was first devised, and for many years afterwards, a well-defined and fairly correct meaning. It must be remembered that it distinctly applies certain practical tests, as aids or guides to the estimate, and depends on the sail a certain specified ship can carry, or the rate at which she sails. Naval officers, by continual practice, attain a high degree of accuracy in estimating the wind, though their ships are no longer of the specified type; but away from their ship they lose their accustomed clue, and the Beaufort scale has, even for them, a very vague and unsettled interpretation; whilst for the greater number of observers on

shore, who never realise what the scale is, the estimates based on it are simple opinions, formed without any recognised standard.

But putting "estimates" on one side, I know of no recorded attempt to measure the wind until, in 1667, the young Royal Society published a revised edition of the "Directions for Seamen," which had been drawn out a few years before by "that eminent Mathematician," Master Rooke. These "Directions," which may be called the precursor of our present *Admiralty Manual*, were edited and enlarged by Dr. Hooke and Sir Robert Moray; and say—*inter alia*: "The strength of the wind is measured by an instrument such as is represented;" and the representation (Fig. 1) shows a plate *CD* suspended, by a bar, from a pivot, and thus able to swing upwards along a graduated quadrant, *AB*; the quadrant itself, with the plate, turning freely, as a vane, on a vertical shaft. It is thus that 1667 has been accepted as the birth-year of modern anemometry: but I would call attention to the

FIG. 1.



Dr. Hooke's Anemometer.

exact words used. They are not, the strength of the wind *may be* measured, &c., but the strength of the wind *is* measured. No inventor's right in, or credit for, the instrument is claimed by any one; and though it has been commonly attributed to Hooke, for aught we can say to the contrary, it may have been in use for many years previous to 1667. It was, however, in this same year that Dr. Croune brought forward an instrument, which consisted mainly of a fan, or rather a sort of paddle-wheel, on a vertical shaft, encased in a drum. The wind was admitted into this drum through narrow longitudinal

slits, and thus caused the wheel to revolve: its indications, however, were found vague and unsatisfactory, and it does not appear to have ever come into actual use. Another instrument suggested by Hooke, in which the velocity, and thus the intensity, of the blast were concentrated, would seem to have given no better results, and to have speedily died a natural death.

Notwithstanding these failures, and the probably earlier origin of Hooke's quadrant, we may take the date 1667 as approximately marking the period in which a general and scientific interest in anemometry began to be felt. From that time onward a very great many anemometers have been invented: at first, indeed, but slowly, and even afterwards there have often been considerable intervals without any new attempts: but at other times they come—to quote an appropriate simile—

"Thick as autumnal leaves that strew the brooks
In Vallombrosa:"—

with the result that the bare enumeration of the different instruments would take the whole evening, and could not but prove wearisome in the extreme. I have, however, attempted to draw up a list,* which is, I believe, the fullest that has yet been got together; and which—though I can scarcely hope that it is perfect—will be worth the attention of any future inventor. It will save him time, and very possibly also much annoyance and vexation: it will enable him to avoid a mistake into which many of his predecessors have fallen, that of re-inventing an already existing instrument. For, in fact, human ingenuity runs in very narrow grooves; and of this vast number of anemometers there are comparatively few that suggest any new anemometrical principle: the majority are merely some modification, improvement or re-invention of some older form. But at present I propose merely to speak of those instruments which may be considered as typical, and which suggest some difference in the method of observing the wind.

The earliest attempts to measure wind were made in the interests of sailors; and to them the important consideration was the pressure: it was the pressure that split their sails, that carried away their spars, or that sent their ships to the bottom of the sea. When the subject began to be scientifically discussed, the first consideration was to enable naval architects to get some correct idea of the strength of the wind which ships, and ships' masts, and ships' sails had to withstand. The earliest types of anemometers were thus different forms of pressure gauges; the earliest of all, as I have just said, appearing to be what—for want of a more correct name—I have called Hooke's, of 1667. This particular type, which may be distinguished as the "pendulum," has been often repeated: amongst others, by the Rev. Roger Pickering, of Deptford, who, in 1744, and without any reference to the former instrument, brought before the Royal Society what he called his anemoscope. It is perhaps a more finished instrument than Hooke's: the swinging plate is held up by a spring catch, so as to show the maximum force that has struck it; and an index at the bottom of the vertical spindle points out the direction

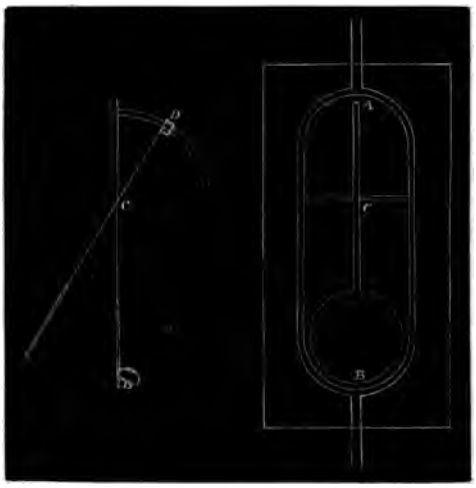
* See post, p. 181.

of the wind: but there is no essential difference between this and the pattern of 1667.

Another instrument of a similar type is that by Dalberg, in 1780. Its details are extremely complicated. Brewster, refusing to be troubled with it, curtly describes it as a mass of "levers and quadrants, and friction-wheels and pulleys, and plumb-lines, combined without judgment or ingenuity." One vane works gearing to show the direction of the wind; another to show the inclination of the wind; and the pressure is shown by a plate which is hinged at its lower edge, whilst the upper is attached to a cord, passing over a pulley and supporting a weight. As the plate is inclined backwards by the force of the wind, this weight is, of course, raised.

A much more simple instrument of this class is that by Dr. Schmidt of Giessen, in 1828* (Fig. 2). A rod AB having a circular plate at its lower

FIG. 2.



Dr. Schmidt's Anemometer.

end, is pivoted at C about one-third of the way down. As it swings back, before the wind, its upper end slides along a quadrant and pushes forward an index D, which remains to show the maximum effect of the gusts. In order to keep the plate face to wind, the rod is pivoted at C in a light frame which itself forms part of the spindle of the direction vane, and turns with it.

Wild's well-known instrument, which is the recognised standard in Russia, is of this "pendulum" class, going back to the primitive type of Hooke's. A somewhat different modification of the same principle was laid before this

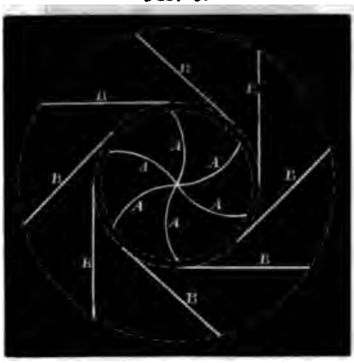
* It must be understood that this and the other diagrams are meant only as indications, and to illustrate the text. No attempt has been made to show the details of construction, or to draw them in scale, or even in relative proportion.

ty by Mr. Howlett, in 1868.* In this, a sphere does duty as pressure- being thus ready for the wind from whatever direction it may come. sphere is at the upper end of a rod, which is pivoted in the middle, and a weight, as a sort of counterpoise, at its lower extremity. As it s with the wind, a pencil traces the direction and the extent, on a or card placed below.

lated to these "pendulum" anemometers, though differing considerably them, are those that have been called "bridled" anemometers, in which winging of the plate is prevented by an interposed resistance. Of this the earliest that has come under my notice is that of Wolf, or Wolfius, in . A set of small windmill-sails on a horizontal axis communicates the n, by means of an endless screw, to a toothed wheel. On the axle of wheel is fixed a rod, at some definite point of which is a leaden weight. ngle through which this weight permits the wheel to turn is a measure force of the wind, and is shown by an index-hand on a dial-face.

upold in 1724 and Leutmann in 1725 published descriptions of an ment of this class, which they each seem to claim. That two men d separately have invented the same not very simple details at the time is out of the question; so we may suppose that this is the joint ction of the two. A sort of paddle-wheel, with six curved sails, can ve on a vertical spindle, on which is fixed a spiral lever or cam. To am is fastened a cord which passes over a leading pulley and supports ght. As the spindle turns, the leverage, and with it the resistance of eight, is increased. The wind is led on to the blades of the wheel— n in horizontal section as *A*—by a number of shutters—as *B*—placed ely round it (Fig. 8): but the compression or concentration which shutters must have produced would seem to have been disregarded.

FIG. 8.



Leupold-Leutmann's Anemometer.

he sphere as a pressure-plate at the end of a swinging rod had been suggested ssibly used many years before, as a rude anemoscope. It is mentioned vaguely lsse (*Allgemeine Maschinen Encyclopädie*, s.v. Anemometer) in 1841; and is said . Bender (*Proc. Inst. Civil Engineers*, 14th March, 1882) to have been used by : but this I have not been able to verify.

This Leupold, who was a mathematical instrument maker, claims the credit of no fewer than 7 different forms of anemometers; amongst which, I must here notice one, ingenious in itself, and interesting, as having been exactly reproduced, about 50 years later, by Benjamin Martin, on the suggestion of Dr. Burton. The pictures and descriptions of the two instruments show no difference. The horizontal axle of a set of windmill-sails has the form of a truncated cone,—a fusee—round which a cord is wound, so as to lift a weight with continually increasing resistance; a contrivance for increasing the resistance which was afterwards used, although in a different manner, by Colonel Beaufoy in 1821. There have been many other instruments of this class, amongst the latest examples of which I may name Mr. Francis Galton's "torsion" anemometer, and Professor Stokes's "bridled:" of this last, one has been set up at Holyhead by the Meteorological Council, not many months ago.

Ronalds' anemometer, though differing considerably from these, must be classed with them. The original type, as presented to the British Association at York, in 1844, consisted of a cross of light wood, *ADBE*, in a vertical plane, pivoted at its centre *C* (Fig. 4). At *A*, a plate, placed by hand fronting the wind. At *E* a small scale pan; at *B* and *D*, counterpoises: weights added to *E* measure the pressure on the plate *A*. This instrument was afterwards modified, so as to turn to the wind by the action of a vane: but its general form remained unaltered.

FIG. 4.

Ronalds' Anemometer.

The Ronalds' anemometer may perhaps be considered as a connecting link between the "pendulum," with which I have classed the "bridled" anemometers, and those more distinctly known as pressure anemometers, in which the pressure-plate is constrained to move parallel to itself. The earliest of this type is that described by M. Bouguer in his *Traité du Navire* in 1746. A piece of cardboard, 6 inches square, is fixed perpendicularly on to a light rod, which presses into a tube, against a spring. This tube is to be held in the hand, and the face of the cardboard presented to the wind, when the pressure is shown by the graduation on the rod. M. Bouguer insists on the lightness and portability of this instrument as its great advantages; for "by holding it parallel to the surface of a ship's sails, the pressure on each square foot of surface is at once found, without having to take into consideration the

obliquity of the impact." The idea of the officer of the watch consulting such a thing as to whether he ought to shorten sail is, of course, ridiculous; but on shore, it might perhaps give an estimate of the pressure on the face of a building, with as near an approximation to truth as many a more refined instrument.

In 1770, the Abbé Nollet, in his *L'Art des Expériences*, describes a modification of Bouguer, as a machine which will tell the force of the wind. He does not claim it as, in any way, his own invention; and, in fact, the only difference seems to be that the rod has ratchet-teeth, and is pauled, as it is pressed into the tube, thus registering the maximum pressure. "The instrument," says the Abbé, "will not measure the actual force of the wind with any great precision: but as that force is itself varying every instant, we may be very well contented with a rough estimate." Ten years later, Colonel Demenge, an Engineer in the Imperial Army, introduced a further and avowed modification of Bouguer. He pivoted it on a vertical spindle; attached a light vane to the far end, so as to make it self-acting; made the plate of thin copper or tin; and by means of teeth on the rod turned a small spur-wheel or pinion, which worked an index outside the tube.

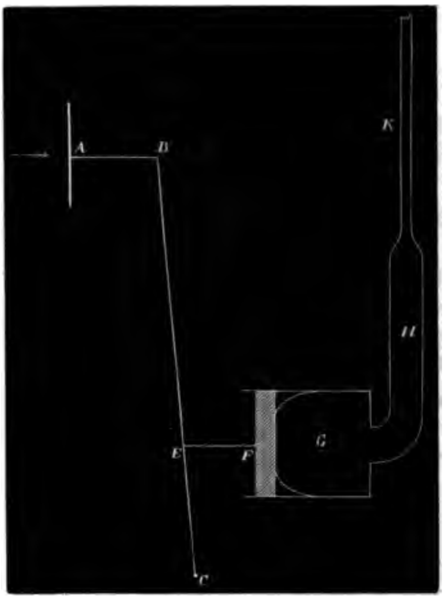
I do not know that the instrument received any further change, till, in 1836, Mr. Osler brought out the first pattern of his anemometer, in which the plate was separated from the vane, and acted on a wire passing down the vane's hollow spindle. In this way he obtained two distinct registers, one of direction, the other of pressure. Mr. Osler has since, from time to time, introduced slight changes in the details of this instrument, the most noteworthy of which, from my present point of view, was the adaptation of a windmill-vane to give direction, instead of the original wedge-shaped vane: but the improvements have been mostly in the registering apparatus; and as an anemometer, the instrument is still essentially the same as it was in 1836. As a pressure anemometer it has been very generally accepted in this country as a standard, and is still in use.

An important modification on the simple pressure-plate was introduced, in 1850, by Dr. Jelinek, who in order to avoid the vacuum behind the plate, cased it in by a cylinder, closed behind, against the base of which it bore, by three spiral springs. Our late lamented Fellow, Mr. Cator, in 1864, attempted to do away with the same source of error, by filling in the back of the plate, making it, in fact, the base of a cone. He also received the pressure on a system of levers instead of a spring, which might be liable to a varying error. How far these modifications render the instrument more trustworthy has, perhaps, not been fully tried: and Mr. Cator's early death has prevented any further development of his ideas on a subject to which he had given much attention.

A somewhat different form of pressure anemometer is that described as an Anemobarometer, by Professor Wilke, of Stockholm, in 1785. The pressure from the plate A is received by one end, B, of a lever, whose fulcrum is at the other end, C (Fig. 5): midway, at E, a projecting arm drives a plunger, F, against a leather bag, G, containing mercury, which is thus pressed up a glass tube, H, and pushes up coloured spirit in a constricted tube, K, above;

thus, evidently, magnifying the scale. Professor Wilke suggested that the lever might very well be dispensed with, and the pressure from the plate brought, at once, to the bag of mercury. This was the plan adopted by Pujoulx some 40 years later (Fig. 6). The pressure was brought to a bladder

Fig. 5.



Wilke's Anemometer.

Fig. 6.

Pujoulx's Anemometer.

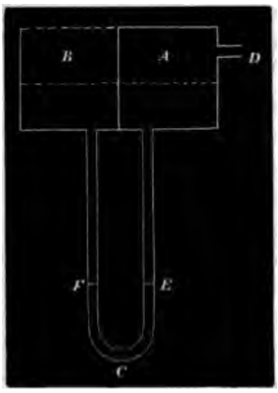
containing air, which, by means of a double siphon-shaped tube, forced a column of coloured liquid to rise.

These may perhaps be rightly considered as nothing more than modifications of Dr. Lind's anemometer, brought out in 1775. This, as is familiarly known, consisted simply of a U tube, swinging freely on a vertical spindle so as to form a direction vane: the tube nearest the spindle was bent back at right angles, so as to present its mouth to the wind, which entering therein, brought pressure on the surface of some water in the tube, forcing it up the other leg: the difference of level gave a measure of the force of the wind. The simplicity of this instrument rendered it a favourite; but it was clearly subject to the disadvantages of having a very contracted scale, and of having no permanent register; though Dr. Lind suggested that by cutting the lee tube off short at the zero mark, the water which was forced out of it would be a measure of the extreme gusts. Nearly 70 years later, Mr. Forbes of Culloden adopted or reproduced this suggestion, connecting, with the zero point of the lee tube, a third tube to receive the overflow. Mr. Forbes also suggested obtaining a more direct register of the maximum force of the wind by putting into the lee tube a slip of cardboard which had been

steeped in a strong solution of sulphate of iron, the tube itself containing a solution of prussiate of potash.

A more important modification, amounting almost to a distinct invention, was that of Dr. Wollaston, which, after his death, was first brought before the Royal Society in 1829, under the name of a "differential barometer". A U tube C, has its legs leading into A and B, the two divisions of a box; of which A is air-tight, except as regards the opening D; whilst B is lightly covered (Fig. 7). The lower part of the tube C contains water to the level EF, but

FIG. 7.



Wollaston's Anemometer.

the upper part of each leg contains oil, which reaches for some way into each of the divisions A and B. When the opening D is presented to the wind, the water is depressed at E, and raised at F; but the head of water at F is partially balanced by the oil above E, so that it indicates a pressure corresponding, not to its own specific weight, but to the excess of its weight above that of the oil. This excess, in Dr. Wollaston's instrument, was about one-eleventh of the weight of the water; and might be still lessened by diluting the water with alcohol; the scale being magnified in the inverse ratio. The principle of this instrument was repeated, it would seem quite independently, by Mr. Ramsbottom, of the London and North-Western Railway Works at Crewe, in 1866. The details proposed by Mr. Ramsbottom differ slightly from those adopted by Dr. Wollaston; but in their main features the two instruments are identical.

Several instruments of a kindred type were suggested by Sir David Brewster in 1830, and were possibly experimented on by him. One of these may be described as an exaggerated thermometer tube laid horizontal, and terminating, at the end opposite to the bulb, in a funnel. The wind blowing into this presses back an index similar to those in a Six's thermometer, compressing the air as it does so. Another, which is more distinctly a modification of Lind, has the lee tube of much smaller bore, with a closed bulb at the top. In the bottom of the U is mercury, which, being forced up the lee leg, attains a

position in which the pressure of the wind is balanced by the head of mercury and the slightly increased pressure of the confined air. A more practical instrument was that brought out by Adie, in 1836, one of which was for several years in use at the Royal Observatory in Edinburgh, and was described approvingly by Professor Piazzi Smyth, in the *Transactions of the Royal Society of Edinburgh* for 1844. In this, the wind, blowing down a bell-mouthed tube, is led into the inside of a cylinder, air-tight above, but open below, which floats in a vessel containing water. This inverted cylinder may, in fact, be compared to a small gasometer, which rises as the pressure of the air inside is increased.

As I now pass on to speak of the measuring of wind velocity, I am tempted to pause a moment to ask what we understand by wind velocity, and what do we want with it? It is frequently said that this is the more important element to meteorologists, as it measures the transfer of masses of air from one place to another. I am quite unable to see how any measurements of velocity made near the surface of the earth can throw very much light on this transfer, for such masses cannot be supposed to move with the velocity indicated by our anemometers. We know, for instance, from balloon observations, that even at a moderate height, the wind often attains a velocity far beyond our experience on or near the surface; and this consideration seems to me to render any deductions as to atmospheric circulation from observations of wind velocity extremely imperfect and doubtful. If, however, we are to consider observations of velocity as mainly another form of observations of pressure, they have, of course, an independent value.

It is in this light that they would seem to have been regarded by Smeaton, who, in and about 1752, carried out a series of experiments for determining the relation between velocity and pressure. The instrument of which he made use closely resembled one previously used by Rouse for similar observations, or another, independently designed by Robins, for determining the resistance of the air.* As adopted by Smeaton, it consisted of a set of small windmill sails on a horizontal axis fixed at the end of, and perpendicular to a bar fastened on the top of a vertical drum, which was made to rotate by a cord wound round it, in the same way that a humming top is set spinning. The windmill sails, put in motion by the equivalent of a current of known velocity, lifted a weight through the mediation of a system of pulleys: and it is on these experiments and on the resulting determinations that the tables, still used for comparing velocity and pressure, mainly depend. Similar experiments were carried out a few years later—in 1766—by Zeiher,† making a Bouguer's pressure plate move with a known velocity by means of a machine practically the same as that used by Smeaton. About the same time, too, Borda,‡ with a similar machine, experimented on the resistance offered by different surfaces moving with known velocity; his experiments were indepen-

* *Philosophical Transactions*, 1759. (Hutton's Abridgment, xi. 355.) Robins, *Principles of Gunnery*, edited by Hutton (1805), p. 200.

† *Novi Commentarii Academiæ scientiarum imperialis Petropolitanæ*, x. 302.

‡ *Histoire et Mémoires de l'Académie royale des Sciences*, 1763; p. 359 *et seq.*

dently repeated, 20 years afterwards, by Edgeworth,* and since then by many others whom it is not now necessary to particularise.

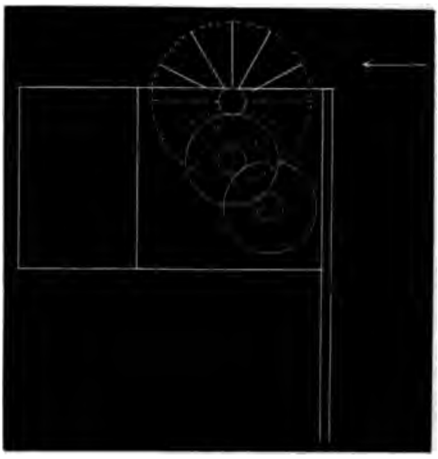
But long before this, certainly before 1680, Mariotte had estimated the velocity of the wind by noting the time that light bits of down or flock took to pass a certain measured distance.† These observations were made again —it would seem quite independently—by Derham,‡ in 1708; but in 1766, Brice,§ repeating Derham's observations, judged them extremely unsatisfactory, and determined rather to note the time of a cloud's shadow; supposing, it would seem, that the velocity of a cloud at some unknown height and the velocity of the wind at the surface of the earth were much about the same. Many different observers reverted to the primitive down, which, even before Brice, had in 1738 been systematised by Bouvet, who noted the flight along a wire of a thin disc of cork lightly feathered. A very similar thing was, about 1840, adopted by Sir W. Snow Harris as a standard measure of velocity. I quote his own description: "To find the velocity by experiment, a cork stuck round with capacious feathers is made to travel over a fine wire of a given length by the force of the wind. The cork is set on a common writing quill, bushed with a small brass plate at each end, and by which the whole is supported on the wire, fine holes being drilled through the brass plates for receiving it. This contrivance is extremely light, and will fly along the wire with the velocity of the wind for a given distance, or very nearly so. It is, in fact, throwing, as it were, a log-line upon the air."

Putting, however, on one side such observations as these, the earliest recorded instrument for measuring the velocity of wind was that of Dinglinger, which may be dated at about 1720, but of which we have no notice beyond a scant mention by Leupold in 1724. It would seem, however, to have been closely followed if not imitated by that of M. d'Ons-en-Bray, in 1734, and had, like this, a clockwork registering apparatus. D'Ons-en-Bray, from this peculiarity, styled his invention the "Pendulum Anemometer;" and it is the earliest with clockwork gearing of which we have any distinct account. But the instrument itself is very complicated. On one side a vane shows the direction of the wind: on the other a horizontal wheel, which he calls a *moulin à la polonaise*, gives the velocity: but the record of both is made through the intermediacy of a quantity of gearing, which must necessarily render the results of doubtful value.

Following this, Lomonosow, in 1751, proposed an instrument of a type which has, I think, remained unique. The half of the direction vane next the spindle is a light thin box, in the upper side of which is fixed a small paddle wheel (Fig. 8); on the axle of this a pinion works a spur wheel, on whose axle another pinion works another wheel, and so, by means of a wire passing down the hollow spindle of the vane, transmits the motion to a wheel below; which might be observed as a measure of velocity for a short time, or, as offering a resistance, as a "bridled" anemometer. We may doubt whether

* *Philosophical Transactions*, 1783; lxxiii. 136.
† *Œuvres* (1717); ii. 406.
‡ *Philosophical Transactions*, 1708. (Hutton's Abridgt. v. 392.)
§ *Ibid.* xii. 338.

FIG. 8.



Lomonosow's Anemometer.

this is properly to be classed as a "velocity" anemometer; but with this exception, I find no attempt to measure velocity instrumentally until Woltmann, in 1790, using a set of small windmill sails, obtained, by means of them, a continuous motion. The same principle was adopted some years later by Dr. Whewell, who, in 1837, brought out the first type of his well-known instrument.

This was, no doubt, an enormous stride in advance; but, notwithstanding the modifications and improvements which were made in it during the years immediately succeeding, it was not found to give satisfactory results when compared by Sir W. Snow Harris with his shuttlecock-like contrivance, of which I have already spoken. The standard was itself not one on which we would now place much reliance; but there is no doubt that the indications of the Whewell anemometer were very wild; a fault due, to some extent, to the very small size of the sails, which had thus a power not always beyond comparison with the resistance offered by the gearing; but due more especially to the remarkable misconception of the meaning of the register. It was supposed that the revolution of the sails was a direct measure of the velocity of the wind. Later experimental observations have shown that it requires to be multiplied by some factor, which is not a constant, but is, roughly speaking, something like 7 or 8.

Following on Whewell, the Rev. W. Foster, of Sturbington, brought out a modified form, in which the wind was received on 4 vertical plates, at the ends of the arms of a horizontal cross. This was fitted to turn only in one direction, and was considered a decided improvement on its predecessor; but it was almost immediately thrown into the shade by the celebrated invention or rather adaptation, in 1846, of the hemispherical cups by that Dr. Robinson who has been so lately taken from us, after having survived to an age far beyond that of ordinary men, and having held to the last a foremost place amongst scientific observers.

It is, of course, quite unnecessary for me to speak in detail of Robinson's cups; but I may mention that in bringing his instrument before the British Association, Dr. Robinson disclaimed the discovery of the property on which it is based. He had, he said, applied a fact "which he had learned from the late Richard Lovell Edgeworth; that if hemispherical cups be carried by horizontal arms attached to a vertical axis, with their diametral planes vertical, they constitute an effective windmill, which he—Dr. Robinson—had found revolves with one-third of the wind's velocity." "To the bottom of the axis is attached wheel-work actuating a revolving disc, which rotates through a degree for every mile traversed by the wind."

Since then, alterations and improvements have been made in the recording apparatus, by Beckley, Osler, Woodward, Hall, and many others; but the anemometer proper remains very much as Dr. Robinson first made it, now nearly 40 years ago. Our Fellow, Mr. J. J. Hall, indeed, in 1871, introduced an ingenious arrangement for maintaining a uniform length of the arms, in a manner resembling that of a compensation pendulum; but it may perhaps be doubted whether this is really an improvement, whether in fact the error arising from the expansion or contraction of the effective radius is not trifling as compared to that which may possibly arise from the increased size and weight of the compensating arms. Of course each new improvement in machinery renders some slight improvement possible; as the latest instance of which I may mention the exceedingly neat bearing of steel balls, on which our Fellow, Mr. Hele Shaw, acting on a suggestion of Professor Stokes, has made his cup-bearing arms to revolve.*

It would be going beyond my present purpose to speak at any length of the different methods which have been used for recording the velocity or even the pressure; but I may recall attention to the very ingenious mechanism by which Professor Arthur von Oettingen proposed to integrate the observations, so as to give at once the mean velocity of the wind resolved along the N, S, E, W lines. In practice, however, I understand that the instrument has been found too complicated for common use. At the last meeting of the British Association, Mr. Shaw showed another type of integrating anemometer, which he had designed in concert with the Rev. J. M. Wilson of Clifton: and still more recently, Sr. Ventosa, of Madrid, has independently invented an instrument very closely resembling Mr. Shaw's, the neatness and ingenuity of which we cannot but admire, even though we are yet unable to speak of it as a well-proved wind recorder.

I may here also mention another method of recording the wind which has, I believe, been found to answer fairly well, but which I now speak of rather as a curiosity of anemometry. As early as 1751, Lomonosow attached to the vane-spindle of his anemometer a vertical wheel, with a tube containing mercury going round the greater part of the circumference, through perhaps 300°. As this wheel, connected with the gearing above, and bridled by a

* A very similar arrangement of friction balls was introduced by Beckley (see B. A. Report 1858, i. 306), but subsequently discarded in favour of a plain bearing.

spring, turned on its axis, as well as, with the vane spindle, in azimuth, a small quantity of the mercury was poured out into a tray below, divided into 32 radiating compartments; the particular compartment in which the mercury was afterwards found indicating the direction of the wind, whilst the quantity of mercury poured out indicated the force. Twenty-six years later, Beaudoux registered the direction, but the direction only, by fine sand falling into a similarly divided tray: and in 1844, Mr. Goddard used water in the same manner. In this instrument of Mr. Goddard, a pressure-plate regulates the outflow of the water from a small cistern, and a vane turns the nozzle, from which the water trickles, over some one of a series of glass tubes ranged round it, one to each point of the compass. "If, for instance, a drop per minute answered to a wind of 1 mile an hour, 2 drops per minute would show a velocity of 2 miles an hour, and so on: and as the tubes collect the daily deposit, by simply reading off the daily elevation of the fluid and noting the respective tube or tubes in which it is found, we have at once the number of miles of air which have passed the station as well as the direction." In saying which, Mr. Goddard was, of course, assuming the relation between pressure and velocity to be satisfactorily established.

Of the same character is the method of registry devised by Sr. Craveri. On a horizontal axis turned by a set of windmill sails, is an eccentric, with a throw of 4 cm. or a trifle more than 1½ inch. This eccentric, by an attached wire leading down the hollow spindle, pulls a bent lever which acts on one of a number of pegs on the face of a wheel, and thus turns the wheel through the space of one peg for each revolution of the windmill sails; at the same time, it also releases a few grains of corn from a vessel above, and allows them to pour into the uppermost of the buckets on the wheel, which resemble the buckets of an overshot water-wheel. As the wheel is turned round, this corn is emptied out into partitions below, each little corn-bin corresponding to a point of the compass; so that the quantity of corn in each represents the relative quantity of wind from that point, as well as, in the aggregate, the mean velocity.

Some, though comparatively few, attempts have been made to measure the inclination of the wind, as well as its velocity and direction. Of Dalberg's instrument, which included a vane for this purpose amongst its complicated devices, I have already spoken. Another, by Benzenberg, was proposed in 1801: the windward end of the direction vane carried a vertical fork, open to the wind, across which was fixed the axis of a horizontal vane. Such a vane would of course show the inclination, but it does not seem to have been connected with any registering apparatus. A more perfect instrument for this purpose was set up at Palermo, about 40 years ago, by Cacciatore, the Director of the Observatory. The velocity of the wind was given by a horizontal fan of 4 curved sails, which being segments—apparently quadrants—of a cylinder, necessarily revolved in one direction, by reason of the same property as that which was more fully utilised by Dr. Robinson a few years later. A similar fan on a horizontal axis was fixed in a rectangular

ame fastened to an upright spindle, so as always to swing away from the ind, and rotate in a plane at right angles to the wind's direction: it could ıus only be acted on by the vertical component of the wind, and recorded s revolutions through the medium of some simple gearing. After being in se for several years, it was blown away in a violent storm: but the new ıemometer set up about 4 years since registers the vertical components in similar manner, a set of Robinson's cups, revolving vertically, being sub-ituted for the original curved fan.

Another method of observing the inclination was brought before the ritish Association, in 1856, by Professor Hennessy. The instrument is escribed as "constructed like a common wind-vane; but instead of the ced tail, a circular disc is placed vertically on an axis passing through the anches of a fork at the tail end. This disc is pierced about halfway etween its centre and circumference, so as to admit another axle, to the ends which are firmly attached 2 light rectangular discs. These discs are ways in a horizontal position, whatever may be the position of the circular isc; for each of them has a pendulum attached to its centre by which the entre of gravity is kept considerably below the axle. The position of the rcular disc will thus very clearly show whether any given current has an pward or downward tendency."

The question of the wind's inclination has also been more recently worked t by Father Dechevrens, of the Observatory of Zi-Ka-Wei, near Shanghai; nd only last year he described the latest form of instrument which he has dopted. In this, the direction as well as inclination is given by a vane apported on a horizontal axis in the fork of a vertical spindle. It has thus he double motion; and the inclination is recorded by means of a small hain and wire, attached in the first instance to a pulley fixed on the orizontal axis, and leading down the hollow spindle.

Although it cannot record its indications, as a mere anemoscope, I do not now that any of these elaborate contrivances excel the simple little feather ane in daily use on board our men-of-war. It is a tapering tail, perhaps inches long and 1½ inch diameter at the thickest, made very lightly of the oftest down or feathers, and tied to the top of a staff by a short thread. Let the wind blow how it will, this must stream from it; and might be used s a most correct indicator, wherever the indicator only, without record, is ranted.

I pass on now to speak of the attempts which have been made to estimate he velocity of wind by its physical effects, rather than by any direct neasure of its movement. The first of these is, I think, that which was nade by Leslie in the very beginning of the present century, and described n his *Experimental Inquiry* in 1804, when he said: "The refrigerant power f a stream of air is exactly proportional to its velocity. Hence we may letermine the rate of cooling that corresponds to any given velocity. From his principle we derive the construction of a new and very simple kind of ınemometer. It is, in reality, nothing more than a thermometer, only with ts bulb larger than usual. Holding it in the open still air, the temperature

is marked: it is then warmed by the application of the hand, and the time is noted which it takes to sink back to the middle point. This I shall term *the fundamental measure of cooling*. The same observation is made on exposing the bulb to the impression of the wind, and I shall call the time required for the bisection of the interval of temperatures *the occasional measure of cooling*." He then proceeds to establish a relation between these two; and taking as the base of his observations, the time of cooling from 20° down to 10° above the temperature of still air, he gives this rule: "Divide the fundamental by the occasional measure of cooling, and the excess of the quotient above unit, being multiplied by $4\frac{1}{2}$, will express the velocity of the wind in miles per hour."

Five and twenty years later, Sir David Brewster adopted the principle that "when water is exposed to wind, the quantity evaporated in a given time is proportional to the velocity of the wind, the capacity of the air for moisture remaining the same;" and proposed a light frame on which was stretched a surface of sponge or coarse flannel to be wetted. This frame was fixed perpendicularly on a light horizontal rod, pivoted on an upright spindle, round which it turned so as to be presented face to wind: on the other arm of the rod was a sliding weight, the rod being graduated as a steelyard. The observed loss of weight gave a measure of evaporation, and so of the wind's velocity.

Perhaps the most curious thing in the history of anemometry is this: that in 1846-48-49, Professor Phillips re-invented the methods of calculating the velocity of the wind from its power of cooling or evaporating, apparently without a suspicion that Leslie or Brewster had anticipated him. If any thing was wanted to show the value of such exhibitions as we are now holding, and of taking stock of our instruments, we should have it in this remarkable fact, that such a man as Professor Phillips was ignorant of what had been done in this department of science by such well-known writers as Leslie and Brewster, and seems to have spent a very considerable time and to have taken a great deal of trouble in doing their work over again.

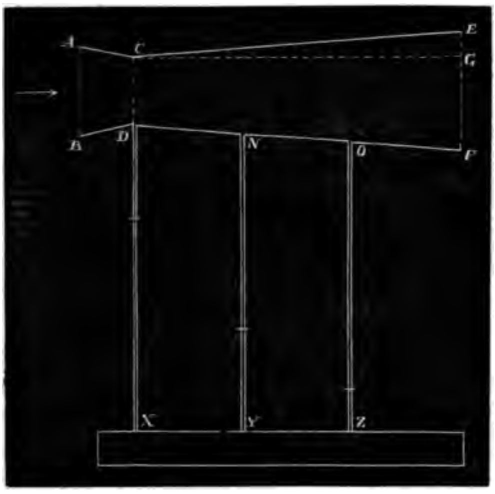
Allied to these methods which I have just spoken of are those which are based on the friction of masses of fluid in motion, and their consequent power of suction. The principle was first illustrated by Bernoulli about the year 1738, but seems to have been comparatively little noticed till, towards the end of the century, it was examined at some length by Venturi, then Professor of Experimental Philosophy at Modena. So far as we are now concerned, the result of these investigations was that if water is made to flow through a pipe composed of two truncated cones joined together at their small ends, the velocity of the stream is enormously increased by reason of the relative vacuum established in the farther cone. This was found to be more especially so in the case of water issuing through a small hole, if the first, or converging cone, was made of the shape of the *vena contracta*: under such conditions the outflow was found to be quickened in the ratio of 41 : 25. The proportions which gave the best result were:—

$$AB = 18,\ CD = 15{\cdot}5,\ EF = 23,\ AC = 11,\ CG = 78.$$

To a tube of these dimensions, in French lines, he connected three tubes, one

at D, the two others at N and O, the points of trisection of DF: these were placed in a trough containing mercury, which rose 53 lines in DX, 20·5 in NY, and 7 in OZ* (Fig. 9).

FIG. 9.



Venturi's Current Meter.

I do not know that Venturi applied his invention, or rather discovery, to the measurement of wind, or even of water currents; but it was so applied in 1854 by Professor Overduyn, of Delft, who used this double cone both as a current meter and as a log, for estimating a ship's speed, in both cases measuring the vacuum by means of an aneroid. He also suggested that air currents might be measured in the same way; but, he says, "when the double cone-shaped tube is used for this purpose, it should be made of larger dimensions, though always in the same proportions. The sucking action of the tube may be rendered more powerful by enclosing it in a larger tube, care being taken to place the front orifice or mouth of the inner tube in the plane of the intersection of the two cones of the larger tube."

I dwell on this, because within these last two months M. Bourdon has proposed almost exactly the same thing, apparently in ignorance of Professor Overduyn's having done so nearly 30 years ago: but M. Bourdon places the rear orifice of the inner tube in the plane of greatest contraction, and proposes a third, placed in the same way inside the second. From the point of contraction of this third tube, a manometer gave a highly magnified indication; and M. Bourdon estimates the effect, taking the suction power of the wind at entry into the tube as unity, as 6 at the contraction of one tube, 20 at the contraction of a second, and 80 at the contraction of a third; and an actual trial gave a rise of 3cm. of water at the mouth of the first, and 1·27m. at the contraction of the third, an exaggeration in the ratio of 1 : 42.

* *Nicholson's Journal of Natural Philosophy*, 1799; ii. 274. Some similar observations were made about the same time by Young: *Phil. Trans.* xc. 106.

This same principle of what Venturi called the lateral communication of the motion of fluids, but without Venturi's tube, was applied by Mr. Fletcher in 1867 to a modification of Lind's instrument, in which the current of air passed freely over the end of the lee tube, thus creating a partial vacuum, whilst the pressure in the weather tube was increased as in the ordinary Lind. This is, in outline, exactly the same as the first anemometer of Hagemann, who, in his second, rejects the windward or wind-catching pipe, measuring only the vacuum caused by the passage of the wind across the free end of the straight pipe. Even in this, however, he had been anticipated by Fletcher, who had proposed connecting a single pipe—" a plain piece of iron gas pipe projecting vertically above the roof of the house "—with one of the limbs of his ether gauge.

There is one other type of anemometer, with a mention of which I may close this list in a swan-like manner. It embraces what we may call the musical anemometers. Doubtless the musical capabilities of wind had been often noticed: in fact, it was impossible for any sailor not to have noticed the sighing or the moaning of the wind through the rigging even when it does not get up to that " piping " of which Allan Cunningham sang. On shore, too, the sighing of the wind amidst the trees—quite a distinct thing from the rustling of leaves—is unmistakable; and there are many other ways in which wind commonly enough makes itself audible. I know, personally, of one old-established ghost that was found to be nothing more than the wind, entering through a cellar grating, vibrating an old, disused and forgotten bell-wire. There is then nothing curious in the fact that, almost from the first idea of measuring the wind, attempts were made to establish a relation between the force of wind and the sound it could produce. Hooke himself suggested some such method, though it does not seem to have been tried. But, about the same time, Athanasius Kircher constructed several instruments to emit musical sounds when the wind blew upon them. They seem, however, to have been of the nature of what we now know as an Œolian harp rather than an anemometer. Leupold, the inventor, wholly or in part, of 7 anemometers, included amongst them one in which the wind manifested itself by its piping; and some years later, in 1782, Delamanon brought out a species of organ, in which pipes were arranged with valves so constructed that the wind blowing on them raised one and closed all the rest: in this way, the note given out told the force of the wind, whilst a pipe of a different set gave out another note for the direction. Such an instrument would probably be expensive; its notes could only be understood by men with a fairly correct ear; it could not in any way be made self-recording, and, in London, at any rate, would very quickly be choked with soot. There may have been other objections to its use; and neither it, nor any of the musical anemometers, would seem to have ever been considered as having any practical value, or, indeed, as anything more than ingenious toys. You may perhaps think that some of the others I have spoken of may be placed in the same category. I do not propose to discuss their merits or their faults in any detail, but I should like, before finishing, to say a few words on the general meaning of

their indications, and on the difficulties which lie in the way of our interpreting them.

We want, for instance, velocity. I put on one side for the present, the question I before referred to, of what we mean by velocity, or what we want it for: I suppose merely that we want to measure the velocity of the wind near the surface of the earth. Do the so-called "velocity" anemometers register it for us? I doubt it very much. In the first place, they all have to work gearing, and gearing is sometimes very heavy. In the early part of last century, the necessity of keeping the gearing light does not seem to have been recognised—the *vis inertiæ* was often ignored. I can give you one extreme instance of this.

We have at Greenwich, on the domes of the College, two vanes; one of which, over the Chapel, swings freely; the other, over the Painted Hall, is connected with an index moving on a dial, which corresponds architecturally with the face of the Chapel clock: I believe that it was set up in the reign of Queen Anne. Now, I noticed that frequently and more especially in light winds, this vane differed considerably from its fellow; sometimes by as much as 8 points; and I suggested to the man who has charge of it that it wanted oiling or cleaning. I found, however, that its sluggishness is due to the work it has to do. It has in fact to turn 2 or 3 pairs of large spur-wheels, one, at least, of 24 inches diameter; 14 pairs of bevel-wheels, and of course the necessary shafting: the whole, I am assured, would be a very good load for a one horse-cart. This is, as I said, an extreme instance; but others nearly as bad, do not seem to have caused any suspicion 150 years ago. The anemometers of D'Ons-en-Bray and Lomonosow are examples of this neglect of what we would now consider first principles. But though, in a very much less degree, every velocity anemometer has its gearing to work; and though this is in most cases beautifully light, and yields to very gentle impulses, it cannot be but that to some extent it affects the coefficient of the instrument.

Again, in this country at least, we have very generally adopted the form of head which we all know familiarly as "Robinson's cups." Now the principle of this type of instrument is based entirely on the difference of the wind-pressure on the concave and convex sides of the cup. Do we know exactly what this difference is? Are the two pressures in a constant ratio, irrespective of the size of the cups or of the force of the wind? I may ask the questions, but I cannot answer them. Dr. Robinson, as you all know, adopted in the first instance 3 as a general and constant coefficient. Later experiments are considered to show that 3 is too large; and 2·5 is now proposed: though this is admittedly only an approximation, and ought in strictness to be changed for every different instrument and for every different wind.

Pressure-plates, on the other hand, have their own difficulties. It is very easy to measure the force with which a plate is pressed, whether against a spring, or a weight, or a system of levers; but it is not by any means so easy to feel sure that that force is the force of the wind. What with stream-lines in front, and a vacuum, often causing an indraught, in rear of the plate,

the problem is far from being as simple as it perhaps seems at first sight. It has been suggested that by having a number of holes in a wall filled in with pressure-plates, or the mouths of Lind's tubes, a correct estimate might be formed of the pressure on that wall: but I know of no attempt to carry out this suggestion to a practical issue. It would be an experiment the value of which is perhaps doubtful, but the great cost of which is very certain. Conditions of expense necessarily limit the range of experiment, and compel us to depend on observations made on a much smaller scale. I understand that Mr. Osler has made many and elaborate experiments in order to arrive at a knowledge of the movements of the stream lines, and the extent or effect of the vacuum; but I am not aware of his having published any account of these. Only last month we had the pleasure of hearing from Mr. Curtis a preliminary account of the experiments he is carrying on in conjunction with Mr. Burton; but it would be, as yet, premature to speak of the results obtained.

And if we do not understand the action of the stream lines on the face of a plate, still less do we understand their action on the face of a sphere, as, for instance, in Howlett's anemometer, an instrument which charms by its neatness and simplicity, although as to the exact interpretation of its readings there may be a good deal of doubt. Nor does the interpretation of the suction anemometers seem to me much more satisfactory. An instrument such as Hagemann (2) captivates the imagination, and leads us to fancy that here we have an anemometer, without machinery of any kind, that catches the wind without interruption, hindrance, or deflection. I am afraid our more serious thoughts do not rate it quite so highly. What do its indications mean? No doubt they can tell us that a wind is blowing over the end of the pipe; or that one wind is stronger than another: but to tell us either the wind-pressure or the wind-velocity is clearly beyond them, without at least the intervention of some other instrument whose indications are themselves doubtful.

I am here speaking only of the anemometers and their indications of the wind actually blowing on them: the very wide question of exposure, of how far the wind that reaches the anemometer is the wind that prevails in its neighbourhood, is beyond my subject for this evening. I will therefore only say in conclusion that none of the existing types of anemometers seems to me to give an undoubted measure of the wind; and that I wish some of our friends who devote much time and labour to refining on the already very delicate gearing and recording apparatus, whether of Osler's plate or Robinson's cups, would consider whether some of their time and skill and ingenuity might not be more advantageously spent in experimenting on new or modified forms of head. But mean time, until we get a perfect instrument, I think it would be advantageous if we could agree on some standard, so that our observations might, at least, be fairly comparable. If our pressure-plates were of the same size and shape; if our cups were of the same diameter, and their arms of the same length; above all, if the instruments were at the same height from the ground, we might perhaps get observations

omparable amongst themselves, and capable, at some future period, of being ghtly interpreted.

APPENDIX.

The following list contains every anemometer of which I have been able to nd any record; but it is scarcely probable that I have not missed several, nd more especially several anemographs, of which the number is very great. n the other hand, I think it probable that I have included several which ave never passed beyond the experimental stage, and some which never ven reached it: I doubt, for instance, if Forster's proposal was ever any ing more than a proposal. The date assigned to each instrument must be nderstood as merely the earliest date at which I find any public mention of ; in many cases the instrument was certainly made and used several years arlier: Dr. Wollaston, for instance, was already dead in 1829, when the escription of his instrument was first published. The letters following the ate denote the class to which the anemometer belongs. Thus:—

- A Pendulum.
- B Bridled.
- C Pressure Plate.
- D Pressure on a fluid.
- E Velocity. With the sub-divisions:—
  - *f* Wheel with axis, horizontal or vertical, perpendicular to direction of wind; exclusive of Robinson's cups.
  - *w* Windmill sails, or fan, with axis in direction of wind.
  - *r* Robinson's cups. (It will thus be understood that instruments noted as E*r* are, with few exceptions, modifications or improvements in the registering apparatus.)
  - *c* Current meter.
- F Evaporation or Temperature.
- G Suction.
- H Direction only.
- K Inclination.
- M Musical.

It has sometimes been impossible to assign the instrument strictly to any ne of these classes: when it seemed to belong in part to each of two classes have so marked it with the two symbols.

Most of the references are at first hand. Those which I have not been ble to verify are marked with a (?). Unless otherwise noted, the Roman umbers signify the volumes, the Arabic signify the pages.

Inventor.	Date.	Class.	Authority.
BRIA,	1851.	E*c*.	Comptes rendus; xxxii. 683.
DIE, P.	(?)	E*r*.	Reduced form of Beckley.
DIE, R.	1836.	D.	Edinburgh New Philosophical Journal; xxii. 309.

Inventor.		Date.	Class.	Authority.
AIMÉ,		1846.	H.	Annales de Chimie, 3me Série; xvii. 498.
ANONYMOUS—				
Boreas,		1827.	C.	Mechanics' Magazine; vii. 264.
N.S.N.		1831.	AD.	*Ibid.* xv. 330.
ARSON,		1876.	G.	Mémoires, &c., de la Société des Ingénieurs Civils; 505.
ATHERTON,		1831.	H.	Edinburgh New Philosophical Journal; xviii. 311.
BALLINGALL,		1874.	CD.	Catalogue of the Special Loan Collection of Scientific Apparatus at the South Kensington Museum, 1876. 3rd Edit. 692.
BANKS,		1846.	C.	British Association Report. Part ii. 12.
BARTHOLD,		1869.	B.	Deutsche Bauzeitung, 221.
BARRETT,		(?)	(?)	(?)
BEAUDOUX,		1777.	H.	Cotte, Mémoires sur la Météorologie, 1788; ii. 308.
BEAUFOY,		1821.	C.	Annals of Philosophy. 2nd Series, ii. 431.
BECKLEY,		1856.	Er.	British Association Report, 1856, ii. 38, and 1858, i. 306.
BENDER,		1882.	C.	Minutes of Proceedings of the Institution of Civil Engineers, 14th March.
BENZENBERG,		1801.	HK.	Gilbert's Annalen, viii. 240.
BIANCHI,		*see* MORIN.		
BIRAM,		1843.	Ec.	Mechanics' Magazine, xxxix. 47.
BOUGUER,		1746.	C.	Traité du Navire, 359.
BOURDON,		1882.	G.	Comptes rendus, xciv. 229.
BOUVET,		1733.	E.	Histoire de l'Académie Royale des Sciences, 100.
BREWSTER,	1.	1830.	CD.	Edinburgh Encyclopædia. s. v. Anemometers.
,,	2.	,,	D.	,,
,,	3.	,,	D.	,,
,,	4.	,,	F.	,,
,,	5.	,,	D.	,,
BROWN (Crum),			B.	Loan Catalogue. 692.
BROWN (Joseph),		1828.	E*f*.	Mech. Mag.; ix. 313.
BRUSOTTI,		*see* PARNISETTI.		
BURTON,		*see* MARTIN.		
BURTON,		1881.	Er.	Nature, Oct. 20.
CACCIATORE,		1840.	E*f*K.	Annuario della Società Meteorologica Italiana; i. 201.

entor.		Date.	Class.	Authority.
LLA,	1.	1866.	Er.	Proceedings of the Meteorological Society; iii. 255.
	2.	*see* PARKES.		
R,		1864.	C.	Proc. Met. Soc.; iii. 49, and iv. 273.
ES,		1837.	Ec.	Annales des Mines. 3me Série; xiii. 103.
ERI,		? 1866.	Ew.	Archives des Sciences Physiques et Naturelles (Genève); Nouvelle Période; xxv. 305.
ILEY,		1873.	Er.	Quarterly Journal of the Met. Soc.; i. 157.
NE,		1667.	(?)	Edin. Encycl.; s. v. Anemometers.
IS,		1881.	Er.	Registers by the agency of a pair of governor balls.
IUS (B. Donker),		(?)	(?)	? Methodi quibus aeris impulsus et venti velocitas determinantur. Lug. Bat. 1826.
ERG,		1781.	AK.	Rozier, Observations sur la Physique; xvii. 488.
I,		1578.	H.	Primo Volume dell' uso et fabrica dell Astrolabio, 251.
EVRENS,		1881.	K.	Sur l'Inclinaison des Vents (Observatory of Zi-Ka-Wei).
MANON,		1782.	M.	Cotte, Mém. sur la Mét.; ii. 312.
A RUE,		1874.	Er.	Brit. Ass. Report; Pt. ii. 37.
A,		1879.	Er.	Anemografo e Pluviografo.
INGE,	1.	1780.	B.	Rozier, Observations sur la Physique, &c.; xv. 483.
,,	2.	,,	C.	*Ibid. Ib.* 486.
CHAU,		1862.	Ec.	Comptes rendus; lv. 843.
UINEMARE,		1815.	B.	C. P. Molard, Description des Machines; viii. 160.
INSON,		(?)	A.	Spon's Dictionary of Engineering, s. v. Anemometers.
S,		1881.	A.	A series of boxes placed on end, face to wind; each box falls back at a known maximum of wind pressure.
LINGER,		? 1720.	Ef.	Leupold, Theatrum Machinarum Generale; 132.
OND,		? 1855.	CK.	A pressure-plate lifting a series of weights.
S-EN-BRAY,		1734.	Ef.	Histoire de l'Acad. Roy. des Sci. 123.
ER,		1869.	AC.	Annual Report of the New York Meteorological Observatory for 1878.
IONCEL,		1851.	Ew.	Comptes rendus; xxxiv. 761.

Inventor.		Date.	Class.	Authority.
ECCARD,		(?)	? E*r*.	? History of Signal Service, U.S.A.; 40.
EDMONDS,		1841.	C.	Quarterly Journal of Meteorology (Gutch); p. 300.
EDWARDS,		1832.	C.	Transactions of Society for Encouragement of Arts, &c.; 1836; vol. l. pt. i. p. 107.
ELLERY,		? 1881.	E*r*.	
ERMERINS,		? 1858.	C.	Verhandelingen van het Koninglijk Instituut van Ingenieurs; 1859-1860; p. 31.
EULER,		(?)	(?)	? Cronholm, J. De Anemometri Euleri Lundæ, 1783.
FLETCHER,	1.	1867.	DG.	Brit. Ass. Report, 1867; ii. 33; 1869 ii. 48, and 1879, 279.
,,	2.	1867.	G.	Brit. Ass. Report, 1867; ii. 33.
FORBES, A.	1.	(?)	D.	Negretti & Zambra, Encyclopædic Catalogue; No. 76.
,,	2.	(?)	D.	Symons's Monthly Met. Mag.; ii. 53.
FORBES, J. D.,		1830.	E.	Edinburgh Journal of Science (New Series); ii. 31.
FORSTER, B. M.,		1828.	F.	Mechanics' Magazine; ix. 272.
FOSTER,		? 1878.	E*r*.	Kingston, G. T. Instructions to Observers in Canada; 98.
FOSTER, Rev. W.		1844.	E*f*.	Brit. Ass. Report, 1844; i. 250.
FRANK,		1831.	E*w*.	Verhandlungen des Vereins zur Beförderung des Gewerbfleisses in Preussen; 1831, p. 257.
GALTON, F.		1879.	B.	A set of Robinson's cups bridled by spring on the vertical shaft.
GIBBON,		? 1873.	E*r*.	Report of U.S. Signal Service, 1873; p. 40.
GODDARD,		1844.	C.	Athenæum, Sept. 21st.
GORDON, J. E. H.		1870.	H.	Engineer, Feb. 25th; p. 110.
GORDON,		(?)	E*r*.	(?)
GOULD,		? 1860.	A.	Barometrical and Thermometrical Register.
GREEN,		? 1878.	E*r*.	Kingston, Instruction to Observers, &c.; 96.
GUIBAL,		1871.	E*c*D.	Specifications of Patents, 1871. No. *173.*
GUSTEAU,		1777.	C.	Cotte, Mémoires sur la Météorologie; *ii.* 307.
HAGEMANN,	1.	1876.	DG.	Q. J. of the Met. Soc. v. 204.
,,	2.	1876.	G.	*Ibid.*
HALL (Henry),		1877.	E*c*.	Telephonic Tell-tale connected with a Biram's Anemometer.

ıtor.		Date.	Class.	Authority.
J. J.	1.	1870.	E*r*.	Horological Journal, Sept. 1st. p. 7.
,,	2.	1872.	E*r*.	*Ibid.* Nov. and Dec., pp. 80, 40.
.L,		1831.	C.	Philosophical Magazine (1832); xi. 100.
',		*see* Morin.		
ɜ, W. Snow,	1.	1841.	C.	Brit. Ass. Report, 1841; i. 87.
	2.	1841.	E.	*Ibid.*
	3.	1858.	D.	Symons's Monthly Met. Mag.; ii. 52.
		1870.	D.	Chemical News; xxi. 200.
IT,		(?)	A.	Spon's Dictionary of Engineering, s. v. Anemometers.
ESSY, H.		1856.	K.	Brit. Ass. Report, 1856; ii. 40, and 1857; ii. 30.
IANN,		1789.	AB.	Mechanischer verbesserter Wind-Regen- und Trockenheits-beobachter.
:-Mangon,		1877.	E*r*.	Annuaire de Montsouris, 1877; p. 360.
,		? 1876.	E*r*.	Catalogue of Meteorological Instruments; 168.
		1871.	E*r*.	Zeitschrift der österreichischen Gesellschaft für Meteorologie; vi. 117.
HMANN,		(?)	E*f*.	Hülsse, Allgemeine Maschinen Encyclopädie, s. v. Anemometer.
E,	? 1.	1667.	A.	Philosophical Transactions; vol. ii. No. 24, p. 444.
	2.	1667.	E.	Edin. Encycl., s. v. Anemometers.
	3.	1683.	E.	Posthumous Works; fol. 1705; p. 562.
	4.	1683.	E.	*Ibid.*
H,		1869.	E*r*.	Annals of Dudley Observatory; vol. ii.; p. xxx.
ETT,		1868.	A.	Proceedings of the British Met. Soc.; iv. 161.
ɜE,	1.	1841.	E*w*.	Allgemeine Maschinen Encyclopädie, s. v. Anemometer.
	2.	,,	A.	*Ibid.*
ι, Sir H.		(?)	E*r*.	Negretti and Zambra Encycl. Cat., No. 79.
EK,		1850.	C.	E. E. Schmid, Lehrbuch der Meteorologie; 488.
ɜTENIUS,		1820.	E*c*.	Hülsse, Allg. Masch. Encycl.; s. v. Anemometer. ? Kongl. Vetenskaps Acad. Handl., 1820.
NER,		1789.	A.	Magazin für das Neuste aus der Physik (Gotha); vol. vi. pt. iii. p. 84.
ɜTON,	1.	? 1876.	E*r*.	Loan Catalogue; 695.

Inventor.		Date.	Class.	Authority.
KINGSTON,	2.	1876.	H.	Loan Catalogue; 696.
KIRWAN,		1810.	C.	Transactions of the Royal Irish Academy; xi. 61.
KRAFT,		1867.	E*r*.	Zeitschrift der öster. Gesell. für Met.; ii. 67.
KREIL,		1850.	A.	Entwurf eines meteorologischen Beobachtungs Systems; 201. E. E. Schmid, Lehrbuch der Meteorologie; 484.
LAUDRIANI,		? 1815.	H.	Parrot, G. H. Grundriss der theoretischen Physik; iii. 421.
LEFEBVRE DES HAYES,		1783.	(?)	Cotte: Mémoires sur la Météorologie; ii. 314.
LEGELER,		1845.	H.	Poggendorf, Annalen der Physik und Chemie; lxxx. 364.
LENZ,		1865.	A.	Polytechnischer Journal (Dingler); clxxvi. 433.
LEROY,		1828.	H.	Bulletin des Sciences Mathématiques; ix. 32.
LESLIE,		1804.	F.	Experimental Enquiry into the Nature, &c. of Heat. 282.
LEUPOLD,	1.	1724.	C.	Theatrum Machinarum Generale. 141
,,	2.		B.	*Ibid.* 142.
,,	3.		A.	*Ibid.*
,,	4.		A.	*Ibid.* 143.
,,	5.		B.	*Ibid.*
,,	6.		B.	*Ibid.*
,,	7.		M.	Gehler, Phys. Wört; iv. 78[illegible]. ? Leupold, Theatrum Aerostaticum; Cap. X. § 122, 131.
LEUTMANN,		1725.	B.	Instrumenta Meteorognosiæ inservientia. 116.
LIND,		1775.	D.	Phil. Trans. lxv. 353.
LOMONOSOW,		1751.	BE*f*.	Novi Commentarii Academiæ scientiarum imperialis Petropolitanæ; ii. 128.
LOWNE,		1874.	E*c*.	Quarterly Journal Met. Soc. ii. 285.
MARTIN-BURTON,		1771.	B.	Benj. Martin, Philosophia Britannica; 3rd Edit. ii. 211.
MONTIGNY,		1854.	C.	Polytechnisches Central-blatt (Neue Folge); 1854, p. 1090.
MORGAN,		1861.	C.	Brit. Ass. Report, 1861, ii. 72.
MORIN-BIANCHI,		1862.	E*c*.	Comptes rendus; liv. 282.
MORIN HARDY,		1864.	E*c*.	Annales du Conservatoire impérial des Arts et Métiers, v. 343.

r.	Date.	Class.	Authority.
r,	*see* PETTENKOFER.		
	1770.	C.	L'Art des Expériences ; iii. 62.
	1789.	A.	Magazin für das Neuste, u.s.w. (Gotha); vol. vi. pt. 1, p. 89.
EN (VON),	? 1876.	Er.	Repertorium für Meteorologie; v. No. 10.
1.	1836.	C.	Brit. Ass. Report, 1837, ii. 38.
2.	1858.	Er.	Brit. Ass. Report, 1858, ii. 38.
3.	1865.	C.	Brit. Ass. Report, 1865, ii. 19.
N,	1854.	G.	Mechanics' Magazine ; lxi. 82.
	1869.	C.	Mechanics' Mag. New Series. xxi. 172 & 196.
	(?)	Ec.	Casella's Catalogue of Scientific Instruments, 1871 ; p. 25.
TI,	1858.	Er.	Anemometrografo alla Specola del Seminario di Alessandria, 1865.
TI-BRUSOTTI,	1869.	Er.	Meteorologia Italiana, Suppl.
LLI, 1 & 2.	(?)	Er.	Loan Catalogue ; 694, 695.
r,	1792.	Ew.	Beobachtungen u. Entdeckungen aus der Naturkunde, von der Gesellschaft naturforschender Freunde zu Berlin; 1792, x. 1.
OFER-NEU-	1862.	Ec.	Mittheilungen des Gewerbe-Vereins für das Königreich Hanover (Neue Folge), 1862. p. 26.
, 1.	1848.	F.	Brit. Ass. Report. Pt. i. 97.
2.	1849.	F.	Brit. Ass. Report. Pt. ii. 28.
	1872.	A.	Zeitschrift d. öster. Gesell. f. Met. viii. 73.
IG,	1744.	A.	Phil. Trans. xliii. No. 473, p. 9.
	1733.	A.	Edin. Encycl. s.v. Anemometers.
	? 1739.	(?)	? Schwedische Abhandlungen, 1739.
NN,	1804.	C.	Voigt, Magazin für den neuesten Zustand der Naturkunde (Weimar); vii. 463.
,	? 1876.	A.	Loan Catologue ; 693.
,	? 1830.	CD.	Edin. Encycl. Anemometers.
	? 1870.	Er.	Zeitschrift d. öster. Gesell. f. Met. v. 81.
TOM,	1866.	D.	Chemical News ; xiii. 52.
1 & 2.	? 1876.	Ec.	Loan Catalogue; 693.
EL,	? 1876.	B.	Loan Catalogue ; 693.
,	1816.	C.	Bulletin de la Société d'Encouragement, No. CL. 15me année, 273.
N,	1846.	Er.	Brit. Ass. Report, 1846. ii. 111.

Inventor.	Date.	Class.	Authority.
ROBISON,	1822.	D.	System of Mechanical Philosophy; iii. 708.
RONALDS,	1844.	BC.	Brit. Ass. Report. i. 129.
RYSSELBERGHE (VAN),	1878.	—	Anemograph. Q. J. of the Met. Soc. ii. 367.
SALLERON,	1881.	Er.	Annuaire de Montsouris, 1882; p. 338.
SCHMIDT, G. G.	1828.	A.	Poggendorff, Annalen der Physik u. Chemie. xiv. 59.
SCHOBER,	? 1791.	Ew.	Gehler, Phys. Wört. iv. 776.
SCHÖN,	1871.	H.	Zeitschrift d. öster. Gesell. f. Met. vi. 246.
SCHUBART, *see* VAN RYSSELBERGHE.			
SECCHI,	1859.	Er.	Memorie dell' Osservatorio del Collegio Romano, (Nuova Serie), 1859. p. 4.
SHAW (Hele),	1881.	Er.	Some Remarks on the Method of Wind Measurement.
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ERENCE OF TEMPERATURE WITH ELEVATION. By GEORGE DINES, .S.

[Read April 19th, 1882.]

stion, owing to the number of observatories which have recently been ed in elevated positions, has in a more marked degree than formerly the attention of meteorologists. It is, however, by no means a new ells, in his *Essay on Dew* (p. 79, Casella's edition), calls attention to vations made by Mr. Six of Canterbury, and states "that on every still night the air near to the earth is colder than that which is more om it, to the height at least of 220 feet."

roceedings of this Society contain a Paper by Mr. Glaisher on the ure and humidity of the air at the heights of 22 feet and 50 feet ground;* and in the *Quarterly Journal* for April, 1872, there is a cation by myself "On the Temperature of Hill and Valley."† These rs will be noticed subsequently. In Vol. III. of the *Proceedings* is nication on this subject by Professor D. Ragona, Director of the ory at Modena; he says, p. 329, that "at 4 p.m. therefore a stratum 3 feet above the ground is generally, *i.e.* under normal conditions, han a stratum of air 121 feet high. Conditions which occasion a n this distribution of temperature are, as already mentioned, rain, nd, fog, &c. As soon as any of these last meteorological elements he lower stratum of air becomes colder than the upper." Again, e says, "At midnight therefore a stratum of air 98 feet above the

* Vol. V., p. 29. † Vol. I., p. 99.

ground is generally, *i.e.* under normal conditions, colder than a stratum of air at a height of 121 feet above the ground."

Observations have also been made at the Oxford Observatory by the late Rev. R. Main, by Professor Wild at the Observatory of Pulkowa, and more recently by Mr. Scott on the Kew Pagoda; but none of these have come under my observation.

It is proposed in this Paper to give a summary of the observations made at my residence, Walton-on-Thames, at different periods during the last 6 years. The stands in which the thermometers were placed were almost identical in size and construction, the only difference being that the one near the ground was 2 feet 4 ins. deep, against 2 feet 11 ins. on the tower. They were enclosed on the four sides (unless otherwise mentioned) with a single louvre board, and well ventilated at the roof. The front of the stands, nearly 3 feet square, was formed as a sliding shutter, in order that it might be lowered for the reading of the thermometers.

One of these stands was placed near the ground at the usual level; the other on the top of a tower, the ascent to which was easy. The bulbs of the thermometers in this stand were about 1 foot higher than the open parapet of the tower, and 50 feet 9 ins. above the ground. Close to the one near the ground was a Glaisher stand, the observations from which were taken at the same time as the others; unless specially named, they have not been used for the purposes of this Paper, but were found useful in checking any doubtful readings. The thermometers were of the best description, all tested at Kew, and the needful corrections have been made.

To complete the Table which follows, eight readings of the different thermometers were required: but owing to my occasional absence from home, and to accidents or omissions in the setting or reading of the thermometers, these were not always obtained. I have therefore on the left hand of the table given the number of days to which the observations refer. The averages, as a rule, have been given to the nearest decimal place, and this will explain any discrepancy that may occur in some of the differences in the table.

Average temperatures only are given in the table, but there are some days on which the differences between the temperature near the ground and that at an elevation of 50 feet cease to exist; or the differences with few exceptions are so slight as not to exceed what might be fairly allowed for errors of observation. The number of days, so far as the table is concerned, on which the maximum temperature at the top of the tower has exceeded that near the ground, has been less than 2¼ per cent. The number of days (or rather nights) on which the minimum temperature at the top of the tower has been less than that of the ground is 21¾ per cent.; of the latter at least one half occurred in rainy weather.

This equality or very slight difference of temperature generally prevails on cloudy days, more particularly so on those when cloud occurs with wind. Rain also appears to have great influence in equalising the temperature above and below. In my Paper "On the Temperature of Hill and Valley" I came

to the conclusion "that in wet, windy or snowy weather, the temperature of the hill is lower than that of the valley." The results there given are in many respects very similar to those given here; but in comparing the two Papers it must be remembered that in the first the difference of elevation was about 550 feet, the stations 6 miles apart, and, what is perhaps of greater importance, the thermometers at both stations were within 4 feet of the ground. In foggy weather some uncertainty prevails; if the fog extends above the top of the tower, there is not much difference in the temperature, though I am disposed to think the air at these times is rather colder above than below; but when the fog keeps near the ground, and does not extend to the upper stand, particularly with a clear sky above, a marked difference is to be found, and it is by no means an uncommon occurrence to find the temperature at 50 feet above the ground higher by 6° or 7° than that at 4 feet.

This leads me to a slight digression from the subject of my Paper. I have for some time tried, but without success, to get at the changes of temperature which occur in the air as fog increases in height; but the great difference in temperature which is to be found when thermometers are placed in the fog and in the air above it, leads me to the conclusion that the upper surface of the fog radiates its heat in a manner similar to grass; by this means the air just above the fog is cooled down, part of the invisible vapour always present in that air is condensed, and forms mist or fog, which thus gradually increases in an upward direction. If this theory be accepted, a great part of the difficulty which exists in explaining the cause of fog will be at an end. Professor Tyndall speaks of clouds increasing in an upward direction in this manner,* and in some meteorological work which I have read, but cannot recall to mind, it is suggested that fogs may arise from the same cause.

In the table which follows (p. 192), the negative sign shows that the temperature was lowest at the upper station, the positive sign that it was highest.

Before making any comments upon the figures in the following table, some observations, all bearing upon this question, but which have been made at other times and for different purposes, may be given.

The temperatures in the sun taken with a black bulb *in vacuo*, both thermometers fixed in the same manner by a socket attached to the stands, were as follows:—In May 1880, 16 days average, 4 ft. above the ground 122°·8; on the tower 117°·8. In June 1880, 23 days, ground 120°·9; tower 116°·3. In July 1880, 27 days, ground 127°·4; tower 123°·2.

Two minimum thermometers, one placed on an exposed board 6 inches above the ground, the other on the tower, gave the following averages:—January 1878, 28 days, ground, 29°·5; tower, 31°·4. February 1878, 26 days, ground, 32°·2; tower, 34°·4. In May 1878, 26 days, ground, 42°·5; tower, 44°·8.

Two minimum thermometers placed upon the Glaisher stand, one of the bulbs 13 inches below the other, gave as an average of 64 days, from May to July, the lower, 48°·1; the higher, 48°·7.

* *Heat as a Mode of Motion.* Chapter ii. paragraph 489.

TABLE SHOWING DIFFERENCE OF TEMPERATURE WITH ELEVATION.

Month.	No. of Observations.	Mean Maxima.		Mean Minima.		Mean Daily Range.		Mean Dry Bulb 9 a.m.		Mean Wet Bulb 9 a.m.		Monthly Rainfall.
		Ground.	Tower.	Ground.	Tower.	Ground.	Tower.	Ground.	Tower.	Ground.	Tower.	
1876.		°	°	°	°	°	°	°	°	°	°	In.
September	26	64·6	—1·6	48·0	+1·0	16·6	—2·7	56·4	—0·4	54·3	—0·8	2·
October ..	29	59·2	—0·8	46·5	+0·4	12·5	—1·1	52·8	—0·2	50·9	—0·3	1·
November	30	50·2	—0·6	37·2	+0·9	13·0	—1·5	43·2	—0·1	41·8	+0·1	2·
December	30	48·9	—0·3	38·2	+0·8	10·6	—1·0	43·9	+0·3	42·7	+0·2	5·
1877.												
January	31	49·2	—0·5	37·0	+0·7	12·2	—1·1	42·6	+0·3	41·6	+0·2	4·
February	27	49·5	—0·5	38·9	+0·2	10·6	—0·7	44·2	—0·4	42·2	—0·2	1·
March ..	31	48·9	—1·2	34·6	+0·7	14·3	—1·9	42·3	—0·7	40·3	—1·3	2·
May	31	57·8	—1·8	40·6	+1·1	17·2	—2·8	51·0	—1·0	48·2	—2·7	2·
June	30	73·4	—2·2	50·2	+1·2	23·3	—3·4	64·1	—1·6	59·5	—3·0	0·
July	31	70·6	—2·3	51·5	+1·0	19·2	—3·3	62·9	—1·8	59·3	—2·1	2·
August ..	14	65·1	—1·8	49·1	+0·8	15·8	—2·6	58·9	—1·3	55·8	—2·0	2·
September	28	61·9	—1·7	43·9	+1·6	18·0	—3·3	54·8	—1·3	52·2	—1·6	0·
October	12	58·2	—0·8	43·3	+1·2	14·8	—2·0	52·0	—0·8	50·5	—1·7	1·
November	27	53·4	—0·5	39·1	+1·2	14·3	—1·7	46·1	—0·3	45·3	—1·2	4·
December	31	46·9	—0·6	34·8	+1·1	12·1	—1·7	40·4	—0·1	39·9	—1·1	1·
1878.												
January	30	45·9	—0·7	35·2	+0·7	10·7	—1·3	40·1	0·0	39·7	—1·1	0·
February	25	47·9	—0·5	38·2	+0·7	9·8	—1·1	42·6	0·0	41·2	—0·2	1·
March ..	26	50·5	—1·5	34·7	+1·2	15·8	—2·7	42·8	—1·0	41·2	—2·0	1·
April	30	57·4	—1·8	40·3	+0·8	17·0	—2·6	49·2	—1·2	48·1	—2·2	3·
May	26	63·6	—1·6	48·0	+0·3	15·6	—1·9	56·9	—1·0	55·0	—2·8	3·4
June	30	70·5	—1·3	50·1	+1·1	20·4	—2·5	63·0	—1·1	59·1	—2·6	2·6
July	31	73·8	—2·1	53·3	+0·8	20·5	—3·0	65·7	—1·9	61·2	—2·3	1·5
August ..	23	72·5	—1·6	55·3	+0·3	17·2	—1·9	64·4	—0·9	61·8	—2·0	4·4
September	19	68·3	—1·3	48·3	+1·5	20·0	—2·8	59·5	—1·2	57·8	—2·2	0·
Means ..	648	58·7	—1·23	43·2	+0·89	15·47	—2·11	51·7	—0·74	49·6	—1·45	..

A most decided difference of temperature with elevation also occurs on many evenings just after sunset. My attention was first directed to this on the evening of the 3rd of September, 1880, at 7.10 p.m., when, on accidentally noticing the thermometers, the temperature was found to be 10° higher at the upper station. Thinking there must be some mistake, the observations were repeated a few minutes later. They were as follows:—Tower stand, 68°·3; on ground, louvre stand, 60°; Glaisher stand, 59°·9. A second thermometer on the Glaisher with the bulb 18 inches lower, 59°·3; 2 inches above grass, 50°·6; on grass, 50°·2. On the 31st of October following, at 7 p.m., the temperatures in the two stands were 68° above, 58°·5 below.

In July, 1881, in order to test the preceding observations, the thermometers were again mounted on the stands; additional precautions were taken to ensure correctness, two wet bulbs being placed in each stand. At this time however the stands were not alike, that near the ground having in the interval been altered by the addition of another louvre board. I do not think that the difference of temperature caused by this alteration would

amount to much, but the tendency would certainly be to make the daily range less than if a single louvre board only had been used.

The times chosen for reading were at 9 a.m., and in the evening about half an hour after sunset, when there was just sufficient light left to observe the thermometers.

The averages were as follows:—29 days, maximum, ground, 77°·6; tower, 74°·9; minimum, ground, 53°·2; tower, 54°·4. At 9 a.m., ground, dry bulb, 67°·8; wet bulb, 61°·8; tower, dry bulb, 65°·5; wet bulb, 59°·5. After sunset, ground, dry bulb, 61°·1; wet bulb, 58°·8; tower, dry bulb, 64°·2; wet bulb, 59°.

The greatest difference in the temperature of the air after sunset during the month occurred on the evening of the 18th, when it was 63°·5 below, 72°·5 above. On six evenings during the month the difference exceeded 7°. On one evening in last December there was a difference of 6°, but as far as my observations extend, the maximum difference occurs in autumn.* As a rule these great differences only occur on calm fine evenings, and when there is a considerable difference between the thermometers in the stands and those upon the grass; but it must not be understood that on such evenings this great difference always occurs. On several occasions, judging from the lower temperature, a considerable difference was anticipated above, and yet it did not amount to more than 2° or 3°. A few instances taken *verbatim* from my Journal may throw light upon this part of the subject.

July 2nd, 1881. Ground, 58°·1; tower, 66°·1. Fine, rather cloudy day. Sky covered with cirrus at night.

„ 4th, „ Ground, 65°·7; tower, 74°·6. Clear. Almost cloudless day.

„ 5th, „ Ground, 67°; tower, 74°·3. Very hot day. Thunder and rain in the night.

„ 15th, „ Ground, 69°·5; tower, 78°·3. Intensely hot day. Clear sky.

„ 17th, „ Ground, 63°·2; tower, 72°·1. Very clear at night.

„ 18th, „ Ground, 63°·5; tower, 72°·5. Very fine calm day. Cirrus very beautiful at night.

A few instances of the reverse to these come next.

July 22nd, 1881. Ground, 58°·1; tower, 58°·3. Dull day, with showers. Fine at night, with a good breeze.

„ 23rd, „ Ground, 62°·5; tower, the same. Night, cloudy, windy, and a little rain.

From the 28th to the 31st of the month (4 evenings) the excess of temperature on the tower only averaged 0°·2; all these evenings have the words "windy and cloudy" entered against them.

* At 7.20 p.m., March 16th, 1882, the difference was 10°·1; tower, 54°·1; 4 feet above the ground, 44°; on board 6 inches above the grass, 30°.

This part of my subject has been entered into at some length for the reason that no particular attention appears to have been called to these great differences, which, as far as my observations extend, occur only at that particular time of the day. This difference as a rule is not caused by any increase of temperature at the upper station, but simply by the more rapid rate at which the air cools near the earth. It may be added here, that the contrast is on some evenings so apparent, that my son, who has often assisted me in these observations, in order that the thermometers might be read simultaneously, has remarked on coming to the ground that it was 'a great coat' warmer above than below.

In July, 1881, the temperatures in the sun, taking the average of 29 days, were as follows:—Ground, 126°·5; tower, 120°·8: the greatest difference occurred on the 9th, when the temperature near the ground was 135°·7; the tower 126°: no single instance occurs during the month of the temperature being highest at the upper station.

My observations during the winter months have been but few, and taken at uncertain intervals; at that time of year it is not an unusual occurrence to find these solar radiation temperatures in excess about 2° at the upper level.

In using the solar radiation thermometers great difficulty was experienced, even when they were placed side by side, in obtaining consistent readings, or in finding the correction, and therefore, as a matter of precaution, the former positions of the thermometers were reversed before these particular observations were taken.

On referring back to the table (p. 192) it will be seen that the average daily range and also the maximum temperature for every month is always greatest at the lower station; the minimum, on the contrary, is less; from this it follows (excluding the exceptional days already noticed) that at two intervals of time during the 24 hours, the temperature at 4 feet and at 50 feet above the ground is equal. The time at which this equality of temperature takes place is a matter of some importance, as in seeking for differences of temperature with elevation the time chosen might be such as to mask any difference that existed at other times. Mr. Glaisher gives 5 to 6 a.m., and 5 to 6 p.m., as the times of equal temperature, but his observations extend only from June 25th to August 6th. The few observations which I have made hourly through the day in the month of July, fully confirm this view, but it will be evident by an inspection of the table that the time varies with the seasons, and that 9 a.m. is nearer the time for the winter months. It will be seen that the temperatures taken at that hour in December and January 1876-7 crossed each other, while in January and February 1878 they were equal.

As to the time when this equality occurs in the after part of the days during the winter months, I have not sufficient observations to decide the question, but as a matter of conjecture should place it at about 3 to 3.30 p.m.

Mr. Glaisher comes to the conclusion that the relative humidity is greatest

during the day at an elevation of 50 feet, and that the contrary is the case at night. My observations upon the dew-point temperature, taken with my hygrometer both at 4 feet and at 50 feet high, have been rather numerous, and as a general rule (with very rare exceptions) the dew-point is lowest at the upper station; but this is by no means inconsistent with the relative humidity being the greatest. Let it be assumed that the weight of vapour in grains per cubic foot is equal above and below, the lesser temperature which generally prevails at the upper station during the day would make the relative humidity greatest at that station. Towards evening the temperature is highest above, and there is no doubt that both the relative humidity and the amount of vapour in the air are less at the higher station.

As a general rule (with rare exceptions) it may be taken that during the day time the temperature decreases with elevation. At night, on the contrary (but with a greater number of exceptions), it increases with elevation up to a certain limit; that limit cannot be defined, in all probability it varies with different seasons and different weather, but on referring back to my former Paper it will be seen that to a great extent the same law for difference of height prevails with 550 feet as with 50 feet.

The greater part of the results given in this Paper were computed at the time the observations were taken, and it is with some hesitation that they have been brought to the notice of this Society. It appears to me that it is to the warming up of the earth's surface by day, and to the cold produced by radiation at night, that the greater part of the differences of temperature recorded are due; and as long as thermometers are placed near the ground, no matter what the elevation may be, they will be affected by the same cause.

DISCUSSION.

Mr. Marriott communicated the results of the Boston observations for the month of March. The Electrical Thermometer (which was shown at the meeting on February 15th) was placed in a wall-screen on the western side of the NNW pinnacle of the church tower, at a height of 270 feet above the ground. A board was also fixed on the south of the screen to keep off the sun's rays. The cable was brought down through the tower and belfry to the base of the church, and there connected with the galvanometer, on which the readings were made. A Stevenson screen, containing dry, wet, maximum and minimum thermometers, was mounted in the SE corner of the tower over the roof of the belfry, at a height of 170 feet above the ground. By permission of the Vicar, a Stevenson screen, containing dry, wet, maximum and minimum thermometers, was established in the churchyard. All the instruments were read daily at 9 a.m., and readings of the electrical thermometer on the top of the tower, and the dry bulb in the screen in the churchyard, were taken every two hours, from 9 a.m. to 9 p.m.; in addition to which the direction and force of the wind and the amount of cloud were also observed. The results of such observations as had been made, showed that the temperature at the top of the tower differed from that near the ground as follows:—

9 a.m.	—1°·3	5 p.m.	—0°·8
11 a.m.	—1·4	7 p.m.	+0·8
1 p.m.	—1·2	9 p.m.	+1·1
3 p.m.	—1·7		

On the belfry (170 feet) the temperature differed from that near the ground as follows:—

9 a.m. ... $-0^{\circ}\!\cdot9$
Maximum $-1\cdot2$
Minimum $+0\cdot4$

The temperature at the upper stations was always lower than that near the ground during the day time, but immediately after sunset it became warmer. During fog, however, the temperature was considerably warmer at the upper stations. For instance, on the 18th, during a dense fog, the temperature at the top of the tower was $4^{\circ}\cdot8$, and on the belfry $2^{\circ}\cdot4$, warmer than on the ground.

Mr. SCOTT said that it was interesting to find the accurate way in which Mr. Dines had observed the weather at the time of observation. In the experiments on the Pagoda at the Kew Gardens the weather was not observed minutely, as each observation involved a walk of nearly 2 miles for the observer, but still the results of the observations made there and those made by Mr. Dines agreed very well together. At the Pagoda during fog a difference of 10° had been observed, the top of the Pagoda being 10° warmer than the lowest station, which was not 4 feet, but necessarily 22 feet above ground, so as to keep the thermometers out of the reach of visitors to the gardens.

Rev. F. W. STOW had never entertained the slightest doubt that the upper surface of a fog must necessarily radiate and be therefore colder than the lower parts of it. He had always found it coldest at the upper station when fog extended to it; but when fog prevailed only at the lower station, the lower station was the colder. Hygrometrical observations were, he thought, very important at elevated stations. His own experience showed that the dew-point, as calculated from Glaisher's Tables decreased slowly and steadily as height increased, although the "relative" humidity might be very variable at different points in the ascent. It was easy to see that on a day which was dry and hot at the lower station, with a difference, say, of 20° between the air temperature and dew-point, the air might be very much colder above, even if the dew-point were the same. On the other hand, in moist weather the diminution of temperature with elevation could not well exceed the decrease in the dew-point. Thus, he believed, there was a distinct connection between the hygrometrical state and the alteration of temperature with elevation. Although he had in a paper called "Upbank Thaws" drawn attention to remarkable instances of increase of temperature with elevation, as Mr. Dines and others had done, he had no doubt that decrease was the rule, but he considered that its amount would be found to depend, in a measure at least, on the absolute amount of moisture in the air. Again, the tendency of a cold shower was to bring, for a time, the temperature of the rain cloud to the ground, and to diminish the rate of decrease with elevation.

Professor ARCHIBALD remarked that the results arrived at by Mr. Dines could only hold for small elevations, and for such, possessed a considerable value, since they indicated the remarkably divergent results that might be expected from comparatively small differences in the vertical position of instruments. For larger elevations, though it seldom happened that the temperature above greatly exceeded that below, the diurnal and seasonal variations in the temperature decrement were analogous to those which occurred much more intensely in the lowest station. Thus Mr. Glaisher, from his balloon observations up to 1,000 feet, had found the difference of temperature for 100 feet to be greatest in the morning and least at night. At Mount Washington, in the United States, the difference between the temperature at the summit and the base was in like manner greater in summer than in winter. The difference of the temperature with elevation had been shown by Blanford and Ferrel to be a most important element in determining the formation of cyclones, cyclones being more easily found where temperature decrements were rapid than where they were slow. The condition of the air over a region with respect to its temperature decrement might thus in time afford some means of forecasting the path and intensity of a cyclone entering it. In conclusion, he had much pleasure in referring to an excellent paper on the Meteorology of NW Himalaya, by Professor S. A. Hill, in which the mean annual temperature was found to decrease very regularly with the elevation, and to amount to about 1° Fahr. for every 357 feet.

Mr. WHIPPLE noticed that Mr. Dines had observed solar radiation. This had not been done at the Pagoda, because no two solar radiation thermometers could be found to agree, and Mr. Dines's plan of changing them had not occurred to him. Experiments were now being conducted at Kew, at the suggestion of Professor Tyndall, with a thermometer placed over swan's down on the ground. It was observed together with other thermometers at 2, 4 and 20 feet, every few minutes from half an hour before to about two hours after sunset, or till fog came on, which equalised the temperature, and made it useless to observe any longer. So far as he remembered the readings on the 16th of March, when Mr. Dines observed such a great difference between the top of the tower and the bottom, there was at Kew a difference of about 20° for an elevation of 20 feet. He thought that it was only possible to get true temperatures in windy or wet weather, and that the observations in fine, calm weather were of little or no use for determining the effect of altitude on temperature.

Mr. C. HARDING remarked that Mr. Glaisher, in his balloon ascents in the autumn and winter months at about the time of sunset, had found the temperature to increase to an altitude of 2,000 feet. He also referred to the observations made by Mr. Glaisher in a captive balloon at Ashburnham Park, and expressed his opinion that much valuable information might be obtained, at a comparatively small cost, by the use of captive balloons. He had compared various series of observations, made with a view of determining the effect of elevation on temperature, and he was compelled to say that the results disagreed in a most discouraging manner.

Mr. DINES, in reply, stated that the Boston figures mentioned by Mr. Marriott confirmed those given in the Paper. Since his Paper had been written the Pagoda observations had been published, and generally they agreed with his own. At first he had been led to think that both Mr. Scott and he had attributed too much influence to fogs in altering the temperature, more particularly so as the great difference 10°·8, recorded at the Pagoda, occurred at 9 p.m., or about the time when he had noticed such great differences of temperature, which most certainly were not caused by fog, as they occurred at times when neither fog nor mist existed. On referring to his papers he found that on one occasion, at 11 a.m., when it was foggy near the ground, the air on the tower was 6° or 7° warmer than at 4 feet, whereas under ordinary conditions it should have been 2° to 3° colder. He thought therefore the paragraph in his Paper might safely stand as he had put it. He was glad to find that Mr. Stow attributed so much influence to the different amounts of vapour in the atmosphere. Working, as he had done, almost solely on that branch of meteorology, he naturally felt great interest in the question ; but the conclusions he had come to were, that it had not so much influence upon meteorological phenomena as was generally supposed. He did not quite understand Mr. Stow's allusion to cold rain in connection with "Difference of Rainfall with Elevation." He had made many observations upon the temperature of rain, and he could not recall a single instance in which the temperature of the rain was below that of the dew-point. On one occasion when a considerable quantity of hail was mixed with the rain, after allowing plenty of time for the slates to cool, the rain came off the roof at a temperature of 54°. On another occasion it was a little over 70° ; and more frequently than not it exceeded the temperature of the air at the same time. The conclusion he had come to (it might be but an idle notion) was, that the rain was warmed in its fall by friction with the air, and by the stoppage of its motion, and thus rendered back to the earth a part of the heat which had been taken away by evaporation. He regretted that he could not discuss Prof. Archibald's remarks as to the influence of vapour upon cyclones, but on one point he had mentioned as to the decrease of temperature with elevation he referred to his paper on the "Temperature of Hill and Valley," where it would be found that on one particularly cold night the temperature at 610 feet above the sea was 13° warmer than at 65 feet. He quite agreed with the remarks that had been made as to the use of balloon observations, and thought the question could only be solved by the use of balloons moored at a fixed height above the ground. Mr. Harding had alluded to the difference in daily range arrived at by different observers. Mr. Dines had been to examine the Pagoda, and surrounded as it was by trees, he felt sure the daily range would be less there than at his place, which was comparatively open.

BAROMETRIC GRADIENTS IN CONNECTION WITH WIND VELOCITY AND DIRECTION AT THE KEW OBSERVATORY. By G. M. WHIPPLE, B.Sc., F.R.A.S., F.M.S., and T. W. BAKER, F.M.S.

[Read April 19th, 1882.]

THE relation of the distribution of barometric pressure to the force and direction of the wind has received much attention from meteorologists, amongst whom the Rev. W. Clement Ley, F.M.S., occupies a prominent position.

Since Dr. Buys Ballot enunciated his well-known law, correlating the two phenomena, many authors have investigated the nature of the connection. Of these we would mention Mr. Ferrel, who anticipated Dr. Buys Ballot in the statement of the law, and has reduced it to a formula,* Dr. Hann, Messrs. Mohn and Guldberg, Loomis, Hamberg and Sprung.

Mr. Ley having calculated the mean wind velocities at the Kew Observatory† for five gradients, it appeared desirable to the authors of this Paper to extend his table as far as possible, both as regards velocity and direction of the wind. Having, therefore, now discussed five years' observations, they submit the results to the notice of the Meteorological Society.

The amounts and direction of the barometric gradients lying over the Kew Observatory have been derived from the Daily Weather Charts of the Meteorological Office for the years 1875 to 1879, whilst the corresponding wind data have been obtained from the hourly readings of the Kew Anemograph, as published also by the Office. The 8 a.m. observations have alone been utilised.

In order to determine the gradients as nearly as possible over Kew, the following pairs of stations were selected as giving lines most nearly intersecting in the neighbourhood of the Observatory:—

N and S gradients	...	Nottingham and Hurst Castle.
E and W ,,	...	Dover and Portishead.
NE & SW ,,	...	Yarmouth and Hurst Castle.
NW & SE ,,	...	Nottingham and Dover.

In the 5 years' observations discussed, well-defined gradients have been determined on 1,095 days, or 60 per cent. The relative proportions for different gradients are as follow:—

TABLE I.

Gradient.	Per cent.	Gradient.	Per cent.
N to S	8	S to N	21
NE ,, SW	7	SW ,, NE	18
E ,, W	7	W ,, E	8
SE ,, NW	23	NW ,, SE	8

Relation of Wind Velocity to Gradient.—It was found that individual observations showed very large variations with respect to this relation, so it

* *Modern Meteorology*, p. 97.

† *Nature*, May 5th, 1881, p. 8.

became clear that, to satisfactorily determine it, a smaller period than 5 years' observations would be useless; the same conclusion was also arrived at by Mr. Clement Ley.

Having accordingly discussed that number of observations, the following mean results were obtained :—

TABLE II.

Gradients per 15 Nautical Miles. In.	Wind Velocity in Miles per hour.	Gradients per 15 Nautical Miles. In.	Wind Velocity in Miles per hour.
0·002	5·0	0·017	15·0
·005	7·0	·020	16·5
·007	7·5	·022	19·1
·010	9·2	·025	22·0
·012	11·6	·027	22·2
·015	12·6	·030	25·5

These numbers when plotted as a curve show that taking the average of a arge number of observations, the rate at which the wind blows increases almost lirectly in an arithmetical proportion with the inclination of the gradient, he mean rate of increase being 1·86 mile per hour for each additional 0025 in. of difference in the barometer readings at each end of the slope.

This appears to be distinct evidence that the motion of air in a cyclonic ystem is not solely due to gravity, for if it were caused by the air simply lowing down from a high level to a lower, the rate would increase as the square oot of the difference in the levels in accordance with the formula $V = \sqrt{2fs}$, where s is the difference of level and f the component of the force of gravity cting in the direction in which the wind is blowing.

Another proof may be deduced from the fact that even with a gradient of 002 in. there is a mean velocity of 5 miles per hour.

Mr. Ley also pointed out that the relation between these two phenomena aries during the year. This has likewise been indicated by the results now btained, and is shown in Table III., where it is evident that the values for

TABLE III.

lean Velocity of Wind in miles per hour for different Gradients in different Seasons.

Seasons.	Gradient per 15 Nautical Miles.											
	In. ·002	In. ·005	In. ·007	In. ·010	In. ·012	In. ·015	In. ·017	In. ·020	In. ·022	In. ·025	In. ·027	In. ·030
June	6·7	7·9	8·6	11·4	13·7	14·8	17·2	19·1	22·1	31·7	24·3	29·0
eptember	6·3	6·0	7·2	10·0	11·6	12·6	16·0	15·0	18·4	15·7	21·0	21·0
ıer Mean	6·5	7·0	7·9	10·7	12·6	13·7	16·6	17·0	20·2	23·7	22·6	25·0
ry-March	3·3	9·8	8·2	8·9	11·7	12·6	14·2	17·7	20·6	19·3	23·2	27·7
er-December ..	3·8	4·3	6·3	6·7	9·6	10·4	12·7	14·6	15·6	21·5	20·6	24·2
r Mean	3·5	7·0	7·2	7·8	10·6	11·5	13·5	16·1	18·1	20·4	21·9	26·0
etween Summer and Winter	+3·0	0·0	+0·7	+2·9	+2·0	+2·2	+3·1	+0·9	+2·1	+3·3	+0·7	−1·0
l Mean	5·0	7·0	7·5	9·2	11·6	12·6	15·0	16·5	19·1	22·0	22·2	25·5

the two summer quarters are in excess of those for the winter quarters by about 2 miles per hour; this difference, however, remains pretty constant throughout the series, and is due to the initial velocity, so to speak, or the velocity with the smallest gradient.

The excess of the velocity for any given gradient, of polar winds over equatorial, already pointed out by Mr. Ley, is shown by Table IV., but the differences are not quite so large as his results have led him to infer.

TABLE IV.

Wind Velocities corresponding to different Barometric Gradients and Wind Direction.

Wind Directions.	Gradients per 15 Nautical Miles.											
	In. ·002	In. ·005	In. ·007	In. ·010	In. ·012	In. ·015	In. ·017	In. ·020	In. ·022	In. ·025	In. ·027	In. ·030
NW gradient, N wind	..	..	7·5	13·0	12·3	13·2	17·9	18·3	17·4	18·3	18·5	19·0
N ,, NE ,,	..	6·0	7·2	9·6	12·2	15·8	15·0	19·8	22·5	22·7	27·0	32·0
NE ,, E ,,	..	9	8	11·3	12·8	13·4	16·6	17·5	23·0	..	..	..
E ,, SE ,,	..	6	6	6	9·2	12·3	11·0	14·3	17·7	14·7	23·0	..
Polar Winds—Means	0·0	7·0	7·2	10·0	11·6	13·7	15·1	17·5	20·1	18·6	22·8	25·5
SE gradient, S wind	3·5	7·2	6·7	9·6	12·7	12·6	15·7	17·0	20·8	24·7	25·0	21·3
S ,, SW ,,	5·0	5·8	8·5	10·2	11·8	14·3	16·0	18·0	19·7	21·8	23	23·2
SW ,, W ,,	7·0	5·8	7·6	7·4	9·0	9·6	13·2	15·2	17·7	18·0	19·7	25·0
W ,, NW ,,	..	7·7	6·7	7·5	12·2	10·7	17·0	16·6	18·0	16·5	17·0	25·5
Equatorial Winds —Means	5·2	6·6	7·4	8·7	11·4	11·8	15·5	16·7	19·0	20·2	21·2	23·8
Difference—Excess of Velocity of Polar Winds over Equatorial	..	+0·4	−0·2	+1·3	+0·2	+1·9	−0·4	+0·8	+1·1	−1·6	+1·6	+1·7

Direction of Wind in relation to Direction of Barometric Gradient or Angle of Deviation.—The mean angle of deviation has been determined for each gradient of inclination and direction; and the results are given in Table V. (p. 201).

These show that the angle at which the wind crosses the line of gradient at Kew does not materially vary with either the steepness of the gradient or the velocity of the wind, and also that, at this observatory, the angle generally lies between 40° and 60°, the average of the whole series of observations giving a deviation of 52°, so that, roughly speaking, with a :—

High Barometer	to the	N	and Low Barometer	to the	S	the wind is	NE
,,	,,	NE	,,	,,	SW	,,	E
,,	,,	E	,,	,,	W	,,	SE
,,	,,	SE	,,	,,	NW	,,	S
,,	,,	S	,,	,,	N	,,	SW
,,	,,	SW	,,	,,	NE	,,	W
,,	,,	W	,,	,,	E	,,	NW
,,	,,	NW	,,	,,	SE	,,	N

TABLE V.

Barometric Gradients and Wind Direction at the Kew Observatory.

Direction.	N.	NE.	E.	SE.	S.	SW.	W.	NW.
aring from N	Pts. 0·5	Pts. 4·3	Pts. 8·5	Pts. 12·5	Pts. 16·5	Pts. 20·3	Pts. 24·5	Pts. 28·5
Gradient.	Direction of Wind blowing across.							
In.	Pts.	Pts.	Pts.	Pts.	Pts.	Pts.	Pts.	Pts.
0·002	..	..	..	18·5	22·5	26·3	..	..
·005	5·0	..	..	18·0	21·0	23·8	30·7	..
·007	4·5	7·0	14·0	19·0	21·2	24·8	30·5	2·0
·010	5·0	6·7	12·5	18·6	21·4	25·0	30·2	2·0
·012	4·2	7·7	14·0	18·0	21·5	24·0	30·0	1·6
·015	4·4	7·6	15·3	18·4	20·8	23·8	30·0	1·2
·017	4·0	7·7	13 2	17·7	20·8	24·2	29·3	0·5
·020	4·2	6·5	13·0	17·6	21·0	23·7	31·0	1·3
·022	4·3	8·0	13·0	18·2	20·7	24·0	28·7	1·6
·025	..	7·0	14·0	18·0	21·0	23·7	31·0	0·3
·027	..	..	15·0	18·6	20·0	24·3	29·5	1·0
·030	..	8·5	..	17·3	..	26·0	28·5	1·0
·032	..	..	..	19·0	21·0	24·0	..	..
·035	..	..	15·0	16·5	..	24·0	..	..
·037	4·0	..	..	..	..	24·0	..	..
Mean	4·4	7·4	13·9	18·1	21·1	24·4	29·9	1·2
ıgle of viation { Points	3·9	3·1	5·4	5·6	4·6	4·1	5 4	4·7
{ Degrees	44°	35°	61°	63°	52°	46°	61°	53°

Mean Angle of Deviation :—Points, 4·6; Degrees, 52°.

ɔ construction of a diagram representing an ideal cyclonic system with ind directions laid off in accordance with the values given in Table V, .tes that the path of the air from the margin to the centre of such a n is not a common, or Archimedean, spiral, but a logarithmic one, as ɜen pointed out by MM. Guldberg and Mohn and others.

ɔ relative frequency of the different gradients, and the different winds to they give rise, is shown in Table VI.. This indicates that at Kew, ı prevalence of N Easterly winds, a gradient of ·012 in. is the most ɜnt, the next highest values being ·017 in. for northerly and ·010 for ·ly winds.

TABLE VI.

uency of occurrence of different Gradients with different Winds. Percentages.

Winds.	Gradient per 15 Nautical Miles.											
	In. ·002	In. ·005	In. ·007	In. ·010	In. ·012	In. ·015	In. ·017	In. ·020	In. ·022	In. ·025	In. ·027	In. ·030
....	1	2	5	7	16	9	26	14	10	5	4	1
E	..	1	5	6	32	15	18	13	7	1	1	..
....	..	1	13	24	21	18	5	6	6	1	..	3
E	..	3	16	17	18	9	16	6	4	5	4	1
....	2	2	14	13	17	13	8	11	9	5	4	2
W	3	8	17	14	20	12	8	6	5	3	2	..
'	2	3	9	23	16	18	6	10	5	3	2	1
W	..	11	20	18	12	13	7	8	4	2	2	2

On the whole, however, there does not appear to be any very marked preponderance of any one particular gradient over others for the winds blowing over the Kew Observatory.

With regard to seasonal distribution, Table VII. shows that steeper gradients are more frequent in winter than in summer, whilst the most common gradient, that of ·012 in., is equally prevalent in all four seasons of the year.

TABLE VII.

Frequency of occurrence of different Gradients in different Seasons. Percentages.

Seasons.	Gradient per 15 Nautical Miles.											
	In. ·002	In. ·005	In. ·007	In. ·010	In. ·012	In. ·015	In. ·017	In. ·020	In. ·022	In. ·025	In. ·027	In. ·030
April-June	1	6	16	15	19	14	11	8	5	1	1	2
July-September	2	7	17	17	19	11	10	8	4	2	1	..
January-March	1	3	9	12	18	15	9	13	8	7	2	1
October-December ..	2	2	12	15	20	14	9	8	6	4	5	1

APPENDIX.

List of Papers relating to the Connection between Barometric Gradients and Wind.

Buys Ballot, Dr.—Journal of the Scottish Meteorological Society, 1873. Vol. IV. pp. 25-26.

Tennent, R., F.R.S.E.—Journal of the Scottish Meteorological Society, 1873. Vol. IV. pp. 97-99.

Ferrel, W., M.A.—"Relation between the Barometric Gradient and the Velocity of the Wind." American Journal of Science and Arts, Nov. 1874. Vol. VIII. "Nature." Vol. IV. p. 226.

Strachan, R. (Resumé of Ferrel).—Symons's Monthly Meteorological Magazine, 1875. Vol. X. pp. 22-25.

Ley, Rev. W. Clement, M.A.—"Nature," 1874, p. 460; 1877, p. 253; 1877, p. 450; 1881, p. 8. The Laws of the Winds. Part I. 8vo, pp. 164, 1872. Aids to the Study and Forecast of Weather. 8vo, pp. 35, 1880. Journal of Scottish Meteorological Society. Vol. IV. 1873, pp. 66-72; 1874, pp. 149-150; 1875, pp. 330-335. Quarterly Journal of the Meteorological Society. Vol. III. pp. 232-237, 1876.

Buchan, A., M.A, F.R.S.E.—Handy Book of Meteorology. 8vo. pp. 280-281, paragraph 565, 1868.

Loomis, Prof. E.—Results of an Examination of the United States War Maps for 1872 and 1873. The American Journal of Science and Arts. Vol. VIII. July 1874; Vol. IX. Jan. 1875.

Hamberg, Dr. H. E.—Sur la variation diurne de la Force du Vent. 8vo, Part I., 1880; Part II., 1881. From Bihang till K. Svenska Vet. Akad. Handlingar. Band 5, No. 24; Band 6, No. 5.

GULDBERG & MOHN, Profs.—Etudes sur les Mouvements de l'Atmosphere. . 1876; 1880. Zeitschrift der oesterreichischen Gesellschaft für Meteo-)gie. 4to. XII. Band. 15 Februar, 1877. Nr. 4, pp. 49-60; and 15 i. Nr. 14, pp. 257-268.

HANN, Dr. J.—Zeitschrift der oesterreichischen Gesellschaft für Meteoro-ie. 4to. X. Band, 15 März, 1875, pp. 81-88; and 1st April, 1875, pp. 106.

TOYNBEE, Capt. H., F.R.A.S.—Remarks to accompany Monthly Charts of teorological data for nine ten-degree squares. p. 485, 1876.

THIESEN, Dr.—Zeitschrift der oesterreichischen Gesellschaft für Meteoro-ie. XIV. Band, 1879, pp. 208-206.

SPRUNG, Dr. A.—Zeitschrift der oesterreichischen Gesellschaft für teorologie. XV. Band, 1880, pp. 1-21; XV. Band, pp. 17-21.

DISCUSSION.

Mr. WHIPPLE, at the conclusion of the Paper, said that acting on a suggestion the Council, he had prepared a brief résumé of the results arrived at by various writers who had investigated the connection between barometric ıdients and wind, which he now read to the Meeting. He had endeavoured to strictly impartial in his abstracts, and, wherever possible, he quoted the author's n words. He regretted that he had not had time to consult more authors than ›se mentioned in the list which he had appended to the Paper. He felt this ›ecially in the case of Dr. Buys Ballot, to whom the law owes its name, and one whose papers he had alone been able to consult.

Dr. TRIPE said that some reference might have been made to the periodical ıds known as monsoons, which were known to the Greeks, and described by istotle. He also referred to Sidi Ali, who, in his work *On the Navigation of Indian Ocean*, published in 1854, gave the periods of the commencement of monsoon at 50 different places.

Prof. ARCHIBALD said that the Paper touched a very important subject, and ıt Mr. Whipple had read a comprehensive *resumé* of the previous writings on subject. He thought, however, that the authors might have attempted a ›re detailed comparison of their results with those arrived at by other investi-tors. He noticed amongst other things, that in measuring the gradients the thors said nothing about the distance of the central area of lowest pressure. ›w, according to the formula given by Mr. Ferrel in his recent monograph cyclones (which had not been alluded to by Mr. Whipple), both gradients and locities should increase independently as the centre of a cyclone was approached. ›reover, although Mr. Whipple had quoted a good deal of evidence adverse to :. Ferrel's formula, which might apply to it in its original form, where no account ıs taken of the inclination of the wind to the isobars, he (Professor Archi-ld) was a thorough believer in the general accuracy of Mr. Ferrel's work, and 1 not think so much objection could be taken to the formula in the new form which it appeared in Mr. Ferrel's latest work, where the angle of inclina-ın entered into the expression. Mr. Ferrel's formula agreed in the main with e theoretical deductions of Messrs. Guldberg and Mohn and Dr. Sprung, and owed that the gradient for the same velocity should (1) increase with the ;itude; (2) increase with the angle of inclination to the isobar, or, in other ›rds, with the amount of friction; (3) increase with the altitude; and (4) minish with an increase in the temperature. Several of these conclusions had en shown to agree with observation. With respect to the angle of deviation, noticed that the authors found it to be the same in all parts of the cyclone, ıereas Ley, Spindler and Loomis found it very different in different gradients, e two former finding it to be greatest for SE winds, and the latter greatest for W winds. As the deviation was closely dependent on the friction of the air ıostly against the earth's surface) the explanation of this fact suggested by indler seemed correct, viz. that in Europe the SE winds mostly blew over

land, while in America the NW wind was the most prevalent land wind. The friction of these winds, and consequently their inclination to the isobars, should thus be greater than for winds blowing from any other direction. Mr. Ferrel's formula for the inclination, moreover, showed that *ceteris paribus* the inclination should (1) diminish with an increase of velocity; (2) increase with the distance from the low centre; (3) increase with a decrease of latitude; and (4) increase with the friction. With regard to the first of these deductions, Mr. Ley had found the inclination smallest for the winds of greatest velocity; the second deduction had still to be proved or disproved, and in favour of the third it might be mentioned that the average inclination in Europe had been found by Mr. Ley to be 24°; by Capt. Toynbee, in the N Atlantic, to be 29°; by Prof. Loomis, for the United States, to be 47°; and from some observations of Mr. Blanford, in the Bay of Bengal, to be 42°.

The Hon. R. ABERCROMBY, after remarking on the great convenience of having things classified as in the present Paper, said that of all writers on winds and cyclones his preference was for the Rev. W. C. Ley, who was about the only one who took observations alone, and did not mix them up with mathematical problems founded upon a few observations. He thought that there were diurnal and seasonal variations of the inclination and force of the wind. The subject of the influence of cyclone motion on wind was well worthy of investigation. Any attempt to connect the wind in a cyclone with the centre alone was useless, as there were always deflections in the shape of the isobars which modified the direction and force of the wind relatively to the centre. He wished to know whether the extremes of force and direction for any particular gradient differed much from the mean.

Rev. F. W. STOW asked whether the velocities used in the Paper depended upon the Kew anemograph; if so, they might require correction, as Dr. Robinson's last experiments showed that the old factor was not correct. He thought that the exposure at Kew might have some influence upon the results obtained, as the observatory was better situated for the registration of E than any other wind. With regard to the ascending current said to exist in the centre of cyclones, he fully believed in it, since he had several times seen it himself, at Aysgarth, 700 feet above sea-level. On these occasions he noticed, at the time of lowest barometer, that the clouds appeared on all sides to be ascending at an angle of 45°, a phenomenon which was speedily followed by heavy rain.

Capt. TOYNBEE called attention to the following graphic remark by the Observer-Sergeant on Pike's Peak (14,216 feet above the sea), as indicating that there was an ascending current of air at the centre of a cyclone:—"June 2nd, 1874. At 2·30 p.m. storm clouds advanced with a violent whirling motion from a point south and east of the summit, and close over the mountains surrounding the Peak in that direction. The vortex crept slowly along the eastern slope of the Peak, and the clouds were hurrying towards it from all directions; thus over the summit they moved from the W and NW, south of the summit from SW and SE, and north of it from NE and N, the whole revolving 'against the sun.' At the same time the clouds had a strong downward tendency, while from the centre of the vortex dense whitish masses of vapour poured upward like volumes of smoke. Thunder and lightning accompanied the storm, and heavy showers of sleet fell on the summit. The wind during and after the storm blew steadily and briskly from the west. At night the weather cleared up, but continuous silent lightning illuminated the entire eastern horizon." Capt. Toynbee also said that he thought the time had come for making a distinction between the cyclone of the tropics and the cyclonic winds of high latitudes. The tropical cyclone was supposed to be related to an approximately circular area of low barometric pressure, having strong winds on all its sides; whereas many of the areas of low barometric pressure which were related to the cyclonic winds of high latitudes were of various shapes, and often had very different gradients on their various sides. For instance, with the prevailing westerly winds of those latitudes, the areas of low barometric pressure were often elongated towards the pole, and had little or no gradient for easterly winds, in which cases the manœuvres applicable to tropical hurricanes were not suitable. Nevertheless, in all cases when it was found requisite for a ship to heave-to, it would be safe to do so according to the rules laid down for tropical hurricanes.

Mr. C. HARDING thought the Paper a very valuable one to seamen, since in

ıandling a ship the matter of indraft was of considerable importance. The 'ormula given by Mr. Ferrel required that the amount of indraft should be the ame in the different quadrants; this was a point of considerable doubt. He :onsidered that the storm which blew in the North Atlantic in August, 1873, ınd which had been discussed by Captain Toynbee, afforded the best existing lata for the inclination of the wind with reference to the centre of disturbance. Ie was of opinion that the difference between the results obtained by Messrs. Vhipple and Baker and those obtained from the American observations might ›e due to the form of anemometer used, and also to the fact that the equivalents n miles per hour for the Beaufort scale as used in America were much lower han the equivalents used in this country: a comparison of this difference would ›e found at p. 81, Vol. V. of the *Quarterly Journal*, in the discussion which 'ollowed the Paper by Captain Watson. He said that careful reading of all the ›ld writers on the Law of Storms would admit of a departure from the circular heory.

Prof. ARCHIBALD remarked that the very small velocities obtained by Prof. ,oomis for America might possibly be due to the great friction encountered by he winds passing over a large continental surface.

Mr. SCOTT said that whatever table of equivalents for the Beaufort scale was ısed by the Americans now, he knew that in the discussion of Sir F. L. 1'Clintock's meteorological observations in the Arctic Seas by Mr. Schott *Smithsonian Contribution* 146, p. 39), the values employed agreed well with those letermined in the Meteorological Office, as he had already stated in the *)uarterly Journal*, Vol. II. p. 113.

Mr. WHIPPLE said that in their paper the authors had no intention to contest heories, but merely to contribute numerical facts. They had found that ndividual observations differed considerably from the average, both as re;arded velocity and the angle of deviation, although the variation of the angle ›f deviation was rather small, and came out much better than the gradient. Vith regard to the American results, in the higher velocities the agreement ›etween the English and the American values was very fair, but in low velocities they did not agree at all. This was possibly due to the form of anemoıeter employed; but there was no doubt that the friction of the air in its aotion over the earth would have made some difference. He thought that the xposure of anemometers was a subject which deserved the attention of meteoroogists, as there were scarcely two anemometers erected which could be conidered as perfectly comparable one with the other under all conditions.

The PRESIDENT (Mr. Laughton) said that though the inclination inwards of he wind in cyclones was perfectly well established as a general rule, it must ıot be forgotten that in the Tropics, at any rate, as Captain Toynbee had pointed ›ut, there were well established observations showing that this inclination was ometimes exceedingly slight, if it existed at all. The historical and precientific performance of the ex-slaver brig 'Charles Heddle' was one instance of his. The brig falling into a violent gale in the South Indian Ocean, was put ›efore the wind and scudded continuously for four days and nights, in which ime she ran five times round the storm area, but never into the centre. This rregularity in the inclination of the wind was a point of the utmost importance o seamen; but, so far as he knew, there was no way of providing against it ›xcept care and watchfulness in each particular case. Referring to what had ›een said about wind-velocity, he said that he had been forced to the conclusion hat few, if any, observations of either wind-velocity or wind-pressure were comıarable. There were many reasons for this, one of which had come promiıently before him during the past few months: this was that observations were aken with every different possible type of anemometer. For any other obser'ation, a man thought it necessary to have a standard and certified instrument, nounted according to a uniform pattern. With the anemometer this seemed to ıave been entirely overlooked: each observer set up his own especial instrunent; even if he used Robinson's cups, he rather carefully avoided any approach o a standard; the length of the arms, the size of the cups, the height above the ;round differed for almost every different instrument; and the result was, and :ould be, nothing but confusion. It might not be possible in the present state ›f knowledge to ensure accuracy as an absolute measurement; but by rigid ıniformity relative accuracy might be obtained, so that observations in different ›arts of the world might be comparable.

PROCEEDINGS AT THE MEETINGS OF THE SOCIETY.

March 15th, 1882.

Ordinary Meeting.

John Knox Laughton, M.A., F.R.G.S., F.R.A.S., President, in the Chair.

Thomas Henry Baker, Mere Down, Mere, Wilts;
John Thomas Barber, F.R.A.S., The Old Hall, Spondon, Derby;
William Hatchett Jackson, M.A., Pen Wartha, Weston-super-Mare.
Capt. Joseph Simpson, Norwich Road, Forest Gate, E.;
Robert Fowler Sturge, 101 Pembroke Road, Clifton, Bristol; and
Admiral Sir Bartholomew James Sulivan, K.C.B., Tregew, Bournemouth,
were balloted for and duly elected Fellows of the Society.

The Paper read was:—

"Historical Sketch of Anemometry and Anemometers." By J. K. Laughton, M.A., F.R.G.S., President. (p. 161.)

After the reading of this Paper the Fellows adjourned into the Library of the Institution of Civil Engineers, where the following instruments had been arranged for exhibition:—

THIRD ANNUAL EXHIBITION OF INSTRUMENTS.

Anemometers.

1. **Osler's Self-recording Pressure Anemometer.** *Exhibited by* A. F. Osler, F.R.S.
2. **Cator's Self-recording Pressure Anemometer.** *Exhibited by* E. E. Dymond, F.M.S.
3. **Whewell's Anemometer.** *Exhibited by* Elliott Bros.
4. **Whewell's Anemometer.** This instrument was used at the Royal Observatory, Greenwich, from 1843 to 1862. *Exhibited by* W. H. Christie, F.R.S., Astronomer Royal.
5. **Robinson's cup and dial Anemometer.** *Exhibited by* The Meteorological Council.
6. " (two dials). *Exhibited by* L. P. Casella, F.M.S.
7. **Fletcher's Anemometer.** *Exhibited by* Chadburn and Son.
8. **Robinson's cup Anemometer** with direction fans and Electrical Registering Apparatus designed by S. M. Yeates. *Exhibited by* Yeates and Son.
9. **Lind's Anemometer.** An old form of this instrument in which the force of the wind is measured by water. *Exhibited by* The Meteorological Council.
10. **Sir Snow Harris' Wind Gauge.** An improved form of Lind's Anemometer. Do.
11. **Modification of Lind's Anemometer,** one limb of the tube being inclined at a small angle to the horizon. *Exhibited by* The Kew Committee.
12. **Pressure Anemometer, by Sir F. Ronalds,** in which the force of the wind is determined by means of a simple balance. This instrument was erected at the Kew Observatory in 1844. Do.
13. **Original Model of Beckley's Self-registering Anemometer,** exhibited at the Meeting of the British Association in 1856. Do.
14. **Recording Apparatus for a Beckley Anemometer,** designed by Mr. De La Rue with a view of affording wind's velocity curve directly applicable to the Galton Pantagraph and Thomson Harmonic Analyser. Do.

15. **Casella's Improved Self-recording Beckley Anemometer.** *Exhibited by* L. P. CASELLA, F.M.S.

16. **Cups and Shaft of Robinson's Anemometer** fixed on the dome of the Kew Observatory in 1856; dismounted in 1867. Since then it has been fitted with a simple counting apparatus (not exhibited) and employed as a standard for comparisons. In 1872 it was used in the experiments at the Crystal Palace by Messrs. Jeffery and Whipple for the purpose of determining the correct value of Robinson's factor. *Exhibited by* THE KEW COMMITTEE.

17. **Registering Apparatus for the above Anemometer.** The wind's velocity only was recorded, the instrument, being fitted inside a movable dome, was not adapted for registration of direction. Do.

18. **Howlett's Self-recording Anemometer.** *Exhibited by* ELLIOTT BROS.

19. **Oxley's Anemometer.** *Exhibited by* THE METEOROLOGICAL COUNCIL.

20. **Wild's Anemometer.** Do.

21. **Hall's Electro-Magnetic Anemometer.** *Exhibited by* J. J. HALL, F.M.S.

22. **Registering Wind Gauge for recording gusts of wind** in pounds pressure per square foot. *Exhibited by* J. SOMERVILLE.

23. **Experimental Anemograph.** *Exhibited by* HELE S. H. SHAW.

24. **Wind Indicator** constructed by Beckley for use at Telegraph Reporting Stations. The first instrument in which chain connection was used in lieu of shafting. *Exhibited by* THE KEW COMMITTEE.

25. **Galton's Torsion Spring Anemometer,** (rough model) Do.

26. **Hagemann's Anemometer** (pattern No. 1.) *Exhibited by* THE METEOROLOGICAL COUNCIL.

27. " " (pattern No. 2.) *Exhibited by* THE COWL COMMITTEE OF SANITARY INSTITUTE.

28. " " (pattern No. 2) in pieces, showing working parts. Do.

29. **6 in. Air Meter,** special construction. Do.

30. **3 in. Air Meter, Lowne's pattern.** Do.

31. **Quadrant for measuring light draughts** by inclination of candle flame Do.

32. **Hicks's Air Meter on Robinson's principle** *Exhibited by* THE KEW COMMITTEE.

33. **Casella's Air Meter,** for Mines, Hospitals and Public Buildings. *Exhibited by* L. P. CASELLA, F.M.S.

34. **Lownde's Anemometer.** *Exhibited by* ELLIOTT BROS.

35. **12 in. Biram's Patent Anemometer** reading to 10 million feet. *Exhibited by* JOHN DAVIS AND SON.

36. **6 in. Biram's Anemometer,** reading to 1,000 feet with disconnecting motion. Do.

37. **4 in. Biram's Anemometer,** reading to 1 million feet, with disconnecting motion. Do.

38. **4 in. Biram's Anemometer,** reading to 100 feet. Do.

39. **2 in.** " " " " Do.

40. **Biram's Anemometer,** reading to 10 million feet, with disconnector and stick holder. Do.

41. **Biram's Anemometer,** reading to 1,000 feet, with disconnector and stick holder. Do.

42. **Model of a self-setting type machine,** for reading the hourly horizontal motion of the air. *Exhibited by* C. J. WOODWARD.

43. **Model of Apparatus to be attached to Robinson's Cup Anemometer** to enable it to indicate the force of gusts. *Exhibited by* R. H. CURTIS, F.M.S.

44. **Specimen of Boxes loaded with different weights** to test overthrow force of wind. *Exhibited by* G. DINES, F.M.S.

45. **Floss-Silk Current Indicator,** as used by Mr. J. F. Campbell for the Committee on Warming and Ventilation, 1856-7.
Exhibited by G. J. SYMONS, F.R.S.

NEW METEOROLOGICAL APPARATUS, &c.

46. **Self-Recording Rain Gauge** (Casella's) with extra open scale.
Exhibited by E. MAWLEY, F.M.S.
47. **New Form of Snow Gauge.** Do.
48. **Electrical Self Registering Rain Gauge,** designed by S. M. Yeates.
Exhibited by YEATES AND SON
49. **Whipple-Casella Universal Sunshine Recorder.**
Exhibited by L. P. CASELLA, F.M.S.
50. **Self-Registering Differential Solar Thermometer,** for recording th maximum Solar Intensity during a day or any other period.
Exhibited by Dr. E. FRANKLAND, F.R.S.
51. **Earth Thermometer** for small depths. *Exhibited by* E. E. DYMOND, F.M.S.
52. **Norwegian Glass float.** Used by the Fishermen of the Loffoden distric for floating Nets. Found near Nain, in Labrador.
Exhibited by THE METEOROLOGICAL COUNCI
53. **Kettle for producing Steam in the Sick Room,** for increasing th atmospheric humidity. *Exhibited by* Dr. W. MARCET, F.R.

PHOTOGRAPHS, DRAWINGS, &c.

54. **Portrait of the Rev. T. Romney Robinson, D.D.,** the inventor of t cup anemometer, died February 28, 1882, aged 89.
Exhibited by G. M. WHIPPLE, B.SC., F.M
55. **Drawing of D'Ons en Bray's Self-Registering Anemometers** inven in the year 1734. (Photo-Lithograph from Engraving in the "Mémoire of the Paris Academy of Sciences.) *Exhibited by* R. B. PROSS
56. **Engraving of an old Anemometer.** A.D. 1667?
Exhibited by G J. SYMONS, F.R.S.
57. **Facsimile of two experimental traces from Osler's Anemometer** at Birmingham, the paper being made to travel under the recording pencils at the extremely high rates of 10 feet and 90 feet per hour. Do.
58. **Facsimile of trace of Osler's Anemometer** at Birmingham, November 10, 1836. Do.
59. **Photographs of Anemometers** or parts thereof, constructed by Mr. L. J. Crossley, F.M.S. A. First sort of contact maker; B. second sort of ditto; C. Kew pattern cups on short spindle for electrical anemometer; D. E. First and second self-registering apparatus. Do.
60. **Photograph of the Anemometer of Lisbon Observatory,** Cups and small pressure-plate Do.
61. **Photographs of side and back view of tipping funnelled rain gauge,** showing vane F to keep the funnel A opposite to the wind's direction in Azimuth, and fans B with counterpoises C C and D and regulator E to keep it opposite to correct altitude. Do.
62. **Photograph from the International Exhibition, Paris,** showing wind vane and small Anemometer as used at the United States Signal Service Stations. Do.
63. **Tracings of Cator's Pressure Anemometer.**
Exhibited by THE METEOROLOGICAL SOCIETY.
64. **Integrating Anemometer.** *Exhibited by* S. H. HELE SHAW, F.M.S.
65. **Anemograph employed at the Stations of the Italian Meteorological Association.** *Exhibited by* PADRE F. DENZA.
66. **Anemometer employed at the Stations of the Italian Meteorological Association.** Do.

7. **Apparatus used for experiments of distribution of wind pressure** upon flat surfaces exposed perpendicularly to the wind.
Exhibited by R. H. CURTIS, F.M.S.

8. **Hall's "Duplex" Electric Anemograph.** *Exhibited by* J. J. HALL, F.M.S.

9. **Hall's Double Action Electro-Magnetic Anemograph.** Do.

0. **Two photographs in the grounds of Bruce Castle, Tottenham,** after the Storm of April 27th, 1868. *Exhibited by* G. J. SYMONS, F.R.S.

1. **Three photographs in Richland Woods, Bodenham, Hereford,** after the Storm of July 7th, 1872. Do.

2. **Map of Newbottle Whirlwind, November 30th, 1872,** showing where the camera was placed for each of six views of the damage and prints of the photographs. Do.

3. **Ground Plan and three photographs of Maltings at Baldock, Herts,** wrecked June 12th, 1875. Do.

4. **Eight photographs of objects damaged by the Cowes whirlwind** of September 28th, 1876. Do.

5. **Map of Path of Walmer Whirlwind, October 24th, 1878.** Plan of same storm on scale of 25 in. to the mile, showing where the camera was placed for each of the 14 views of the damage, and prints of the photographs. Do.

6. **Rough plan of damage by whirlwind at Bramham Park, Tadcaster, Yorkshire,** July 31st, 1881, and photograph of damage. Do.

7. **Six photographs of the Climatological Station on Beacon Stoop, Weaver Hills, Staffordshire,** 1,216 feet above sea level.
Exhibited by C. L. WRAGGE, F.M.S.

8. **Two photographs, showing the Meteorological Station at Farley, Staffordshire.** Do.

9. **Two photographs showing the Climatological Station, at Oakamoor, Churnet Valley, Staffordshire.** Do.

0. **Photographs of external and recording portions of Prof. Stokes's Bridled Anemometers** and traces produced by the same.
Exhibited by THE METEOROLOGICAL COUNCIL.

1. **Five photographs of Anemometers in position.**
Exhibited by L. J. CROSSLEY, F.M.S.

2. **Photograph of Electrical Recording Anemometer.** Do.

3. **Horne's Direct-acting Anemograph with Robinson's cups.**
Exhibited by G. H. HORNE.

APRIL 19th, 1882.

Ordinary Meeting.

JOHN KNOX LAUGHTON, M.A., F.R.G.S., F.R.A.S., President, in the Chair.

CHARLES PERCEVAL BOLTON, Brook Lodge, Waterford;
JOHN DALE, 23 Park Green, Macclesfield;
Capt. GERRARD GAYE, Clairville, The Park, Highgate, N.;
THOMAS THOMAS MARKS, Assoc.M.Inst.C.E., Stratford Villa, Llandudno;
GEORGE NEAME, Surrey House, Littlehampton;
ABRAHAM FOLLETT OSLER, F.R.S., South Bank, Edgbaston, Birmingham; and
Miss ELIZABETH ISIS POGSON, Meteorological Office, Madras,
re balloted for and duly elected Fellows of the Society.

The following Papers were read :—

"ON DIFFERENCE OF TEMPERATURE WITH ELEVATION." By GEORGE DINES, F.M.S. (p. 189.)

"BAROMETRIC GRADIENTS IN CONNECTION WITH WIND VELOCITY AND DIRECTION AT THE KEW OBSERVATORY." By G. M. WHIPPLE, B.Sc., F.R.A.S., F.M.S., and T. W. BAKER, F.M.S. (p. 198.)

RECENT PUBLICATIONS.

ANNUAIRE DE LA SOCIÉTÉ MÉTÉOROLOGIQUE DE FRANCE. 29me Année, 1881. 3me Trimestre. 4to. 1882.

Contains :—Résumé des observations centralisées par le Service hydrométriques du bassin de la Seine, pendant l'année 1880, par M. de Préaudeau (50 pp.). —Sur la température extraordinaire de juillet 1881, par M. E. Renou (2 pp.).—Sur la nécessité d'un cable sousmarin entre la Réunion et Maurice (2 pp.).—Sur un nouveau système de notation et de cartes météorologiques, par M. C. Ritter (5 pp.).

BRITISH RAINFALL 1881. ON THE DISTRIBUTION OF RAIN OVER THE BRITISH ISLES, DURING THE YEAR 1881, as observed at more than 2,000 stations in Great Britain and Ireland, with articles upon various branches of Rainfall Work. Compiled by G. J. SYMONS, F.R.S. 256 pp. 8vo. 1882.

In addition to the notes on the Meteorology of 1881, general tables of total Rainfall, and other information, there are papers on the following:—On the fluctuation of the fall of Rain in England, 1830 to 1881 (17 pp.); the Snowstorms of January 17th to 21st, 1881 (6 pp.); On the rainfall observations made upon York Minster by Professor John Phillips, F.R.S.; by G. J. Symons, F.R.S. (5 pp.).

MINUTES OF PROCEEDINGS OF THE INSTITUTION OF CIVIL ENGINEERS. Vol. LXIX. Session 1881-82. Part III. 8vo. 1882.

Contains:—The design of structures to resist wind-pressure, by C. B. Bender (40 pp.).—The resistance of viaducts to sudden gusts of wind, by J. Gaudard (18 pp.)—with an abstract of the Discussion upon the papers.

PROCEEDINGS OF THE BRISTOL NATURALISTS' SOCIETY. 8vo. 1882.

This contains a paper "On the decrease of Rain with elevation," by George F. Burder, M.D., F.M.S. (17 pp.). After tracing the history of this question, the author says that it is impossible to doubt that the main cause of the observed decrease of rain with elevation is to be found in the force of the wind.

PROCEEDINGS OF THE ROYAL IRISH ACADEMY. Science. Vol. III. Ser. II. No. 7. December 1881. 8vo.

Contains a paper by Mr. Philip Burton on Halos and Anthelia (4 pp.).

PROCEEDINGS OF THE ROYAL SOCIETY. Vol. XXXIII.-XXXIV. Nos. 219 and 220. 1882. 8vo.

Contains :—Preliminary Report to the Solar Physics Committee on a comparison for two years between the diurnal ranges of Magnetic Declination as recorded at the Kew Observatory, and the diurnal ranges of Atmospheric Temperature as recorded at the Observatories of Stonyhurst, Kew and Falmouth, by Balfour Stewart, LL.D., F.R.S. (11 pp.).—On the constituent of the Atmosphere that absorbs radiant heat, II., by S. A. Hill (2 pp.).—On Actinometrical Observations made in India at Mussooree in autumn of 1880, and summer and autumn of 1881, by J. B. N. Hennessey, F.R.S. (9 pp.).

Results of Meteorological Observations made at the Radcliffe Observatory in the Year 1880, under the direction of Edward James Stone, M.A., F.R.S., Radcliffe Observer. Vol. XXXVIII. 8vo. 1882.

In addition to the usual information and tables, this volume contains the hourly readings of the barograph, thermograph and hygrograph from March 1st to December 31st; also tables giving the monthly means of the barometer and temperature (dry and wet bulb) for the 26 years, 1855 to 1880; the mean monthly amounts of rain for the 30 years, 1851 to 1880; and the mean monthly amounts of ozone for the 14 years, 1867 to 1880.

Sitzungsberichte der kaiserlichen Akademie der Wissenschaften. Band LXXXV.—II. Abth. März-Heft. 1882. 8vo.

Contains:—Ueber den Föhn in Bludenz, von Dr. J. Hann (25 pp.).

Sitzungsberichte der königlich Böhmischen Gesellschaft der Wissenschaften. April 1882. 8vo.

Contains:—Ueber den täglichen Gang des Luftdruckes und der Luft-temperatur in Prag, von Dr. Franz Augustin (15 pp.).

Symons's Monthly Meteorological Magazine. May to July, 1882. Nos. 196-198. 8vo.

Contains:—Daily Atlantic Weather Maps (5 pp.).—The Anemometer Exhibition (4 pp.).—Gale of April 29th and sea-spray in London (6 pp.).—Sunspots, magnetic storms and aurora australis (3 pp.).—Resumption of the Ben Nevis meteorological observations, 1882, by Clement L. Wragge (4 pp.).

The Journal of the Royal Agricultural Society of England. Second Series. Vol. XVIII. Part I. 1882. 8vo.

Contains:—On the amount and composition of the rain and drainage-waters collected at Rothamsted. Part III. By J. B. Lawes, LL.D., F.R.S., J. H. Gilbert, Ph.D., F.R.S., and R. Warington, F.C.S. (71 pp.).

The Scientific Roll, and Magazine of Systematized Notes. Conducted by Alexander Ramsay, F.G.S. Climate. Vol. I. No. 7. 8vo. 1882.

This No. is devoted to the subject of Aqueous Vapour, and contains Bibliography from 1682 to 1874 (12 pp.), and Notes on some of the older works (17 pp.).

Zeitschrift der österreichischen Gesellschaft für Meteorologie. Redigirt von Dr. J. Hann. XVII. Band. May-July, 1882. 8vo.

Contains:—William Ferrel's Untersuchungen über atmosphärische Wirbel, von Dr. A. Sprung (22 pp.).—Die Schwankungen des Sauerstoffgehalts in der Atmosphäre, von Prof. C. A. Volger (6 pp.).—Ueber einige Methoden zur Bestimmung der Höhe der Wolken, von O. Jesse (6 pp.).—Die Höhe des Nordlichtes, von H. J. Greneman (10 pp.).—Ueber Anemometer für meteorologische Stationen, von H. Wild (5 pp.).—Ueber den Einfluss der Alpen auf die Vorgänge in einem darüber hinziehenden Luftdruckmaximum, von F. Lingg (18 pp.).—Erläuterungen zur Karte der Häufigkeit und der mittleren Zugstrassen barometrischer Minima zwischen Felsengebirge und Ural, von Dr. W. Köppen (11 pp. and plate).—Die Luftströmungen über Berlin, dargestellt nach den Ergebnissen dreijähriger in fortlaufender Reihe fortgesetzter Wolken- und Windmessungen, von Dr. F. Vettin (9 pp.).

QUARTERLY JOURNAL

OF

THE METEOROLOGICAL SOCIETY.

VOL. VIII. No. 44.

ON THE DIURNAL VARIATION OF WIND AND WEATHER IN THEIR RELATION TO ISOBARIC LINES.—By the HON. RALPH ABERCROMBY, F.M.S.

[Read May 17th, 1882.]

IN a paper read before the Society on November 21st, 1877, entitled "On the General Character and Principal Sources of Variation in the Weather at any part of a Cyclone or Anti-cyclone,"* after pointing out that a series of consecutive observations on the physical appearance of any given weather at a single place might be considered as a continuous record in section of that weather, while synoptic charts at definite intervals of time would show the same changes in plan, I proceeded to indicate how observations on the former would affect the latter if they could be taken at shorter intervals than 24 hours.

The nature of the argument used was as follows:—Since in a large number of cyclones it is found that whenever the barometer turns to rise there is a squall, this, being independent of the time of day, must be referred to that part of the cyclone for its origin; and since this phenomenon occurs at all places over which the cyclone trough passes, however distant from its centre, if a synoptic chart could be made with a large number of stations close together, a line of squalls would be seen under the trough of the cyclone marking all the points at which the barometer turned to rise simultaneously. If on the contrary in many cyclones the wind is stronger and the weather more wet and cloudy in the middle of the day than during the night, it may be concluded that the source of this variation must be diurnal, or due to the time of day, and not to the position of the cyclone centre. Also since a cyclone has always a characteristic patch of rain near the centre, surrounded by a ring of cloud, it follows that in a synoptic chart for the middle of the day, the wind should be found stronger, and the rain and clouds extending further from the centre, than in a chart constructed for an epoch during the night or early morning.

* *Quarterly Journal*, Vol. IV. p. 1.

When the former Paper was written, no materials were available except the Daily Weather Charts drawn at 8 a.m. Since then, through the courtesy of the Meteorological Office, I have been placed in possession of a considerable number of the United States Tri-Daily Charts, and the object of this Paper is by means of them to illustrate the above principles as far as regards the diurnal variation of the force and direction of the wind, and the diurnal increase of rain and cloud. I am also indebted to the same office for the materials used in the construction of the wind curves given in this Paper.

As regards the diurnal variation of the force of the winds, figs. 1, 2, 3, are reductions of the United States daily charts for January 20th, 1873, at 11 p.m., together with the 4.35 p.m. and 11 p.m. charts for the 21st.

These charts may be taken as representing a freely moving cyclone, the intensity of which, as measured by the gradients, is constant; but looking at the wind arrows it will be seen that while in the two 11 p.m. charts there is only one station in the first where the wind exceeds 20 miles an hour, and none in the second, the 4.35 p.m. chart not only has three stations with that velocity, with one over 30 miles, but contains a far larger number of arrows indicating more than 10 miles an hour.

The original records show that the total miles of wind at all the 75 reporting stations in the first chart is 449 miles, with 8 calms; in the second, 681 miles with only 5 calm stations; while in the third chart, the wind has fallen to 420 miles, and the calms have increased to 12, though the gradients remain pretty constant. A similar increase of velocity can be shown to happen in anti-cyclones.

Next, as regards the diurnal variation in the wind's direction, though not very obvious owing to the smallness of scale, still on the whole the arrows in the 4.35 p.m. chart will be found rather less incurved than in either of those at 11 p.m. relative to the cyclone centre, so that at every station the wind, from whatever direction it blows, will appear to veer a little with the sun during the day, and back again towards night, unless overridden by the greater changes due to the cyclone's motion. Similarly, if the charts had been constructed at the same hours for an anti-cyclone, the wind would have been found a little less outcurved, and at every station the wind would have veered a little during the day and then backed again towards night.

Considering, then, both the variation of velocity and direction, these charts show that there is greater velocity for the same gradients and less incurvature at 4.35 p.m. than at 11 p.m., and that if at any particular station the wind fall or change otherwise than diurnally, this is due to the motion of the cyclone overriding that variation. If, then, to give the utmost generality, the changes of wind due to the changes in the distribution of pressure, whether cyclonic, anti-cyclonic, or otherwise, be called general changes, the foregoing results may be summed up in the statement that the resultant wind during any day is the sum of the general and diurnal variations.

I have, unfortunately, been unable to procure any anemographic records from the United States for these days, nor have I been able to make satis-

Fig. 1.

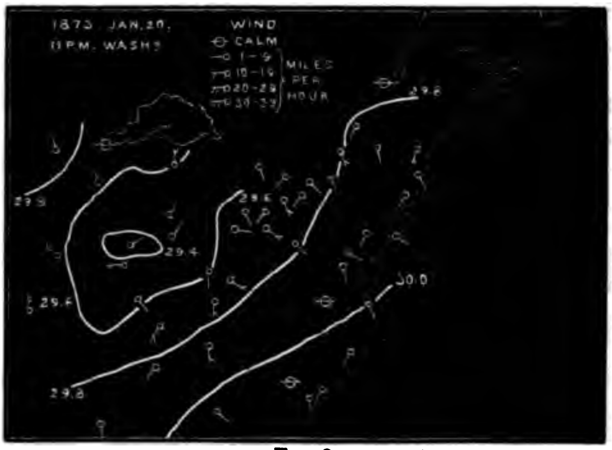
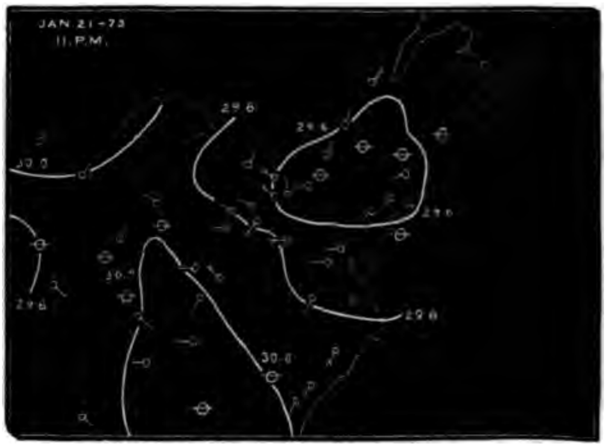


Fig. 2.

Fig. 3.



factory tri-daily charts for Great Britain, where such records are available; still, by combining the facts just shown with the following illustrations, their meaning will be sufficiently clear.

In figs. 4 and 5 are given synoptic charts at 8 a.m. for August 7th and 8th, 1874, which may be considered typical of eight-tenths of British weather, that is to say, a cyclone of moderate intensity passing to the north of these Islands; while in fig. 6 are given the Kew anemograms for those two days as well as the preceding one. In the velocity trace for August 6th

Fig. 4.

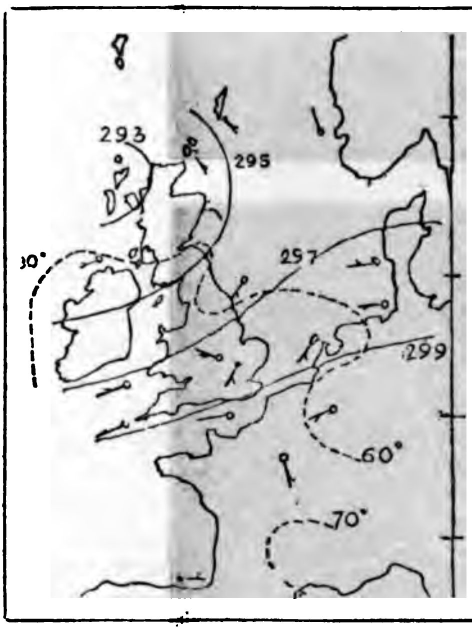


Chart for August 7th, 1874.

Fig. 5.

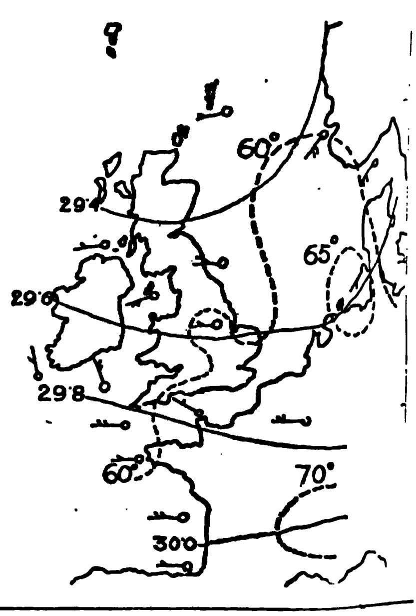
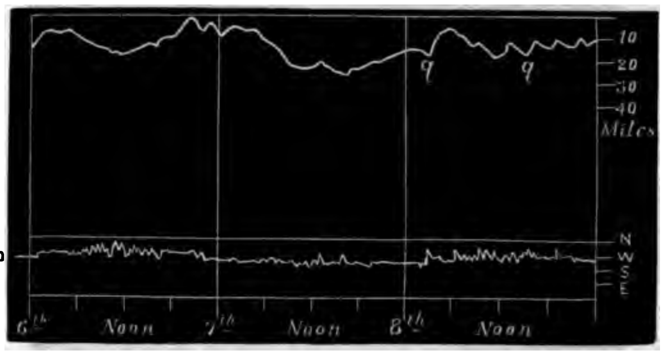


Chart for August 8th, 1874.

Fig. 6.

Velocity

Direction



Anemographic Curves for Kew, August 6th-8th, 1874.

the diurnal variation is pretty normal, and the general velocity about that due to the ordinary gradients; while on the 7th, though the whole amount of wind is considerably greater, owing to the influence of the steeper cyclone gradients, still the diurnal changes are easily read.

On the 8th the changes may at first seem irregular; but when it is known from other sources that the first sharp change, marked q, is due to a squall during the passage of the cyclone's trough, and that the second abrupt change, marked q, is due to a local squall in the rear of the cyclone, then the diurnal maximum about noon is obvious.

Similarly with regard to the direction trace. On August 6th the general direction of the wind is about the most usual at Kew, and the diurnal veering of about one point of the compass is easily seen. On the next day the general direction of the wind has backed considerably owing to the influence of the cyclone seen in the first chart; but in spite of that, about noon, a tendency of the gusts to work a little more round to the west is observable, while on the third day, after the wind has suddenly veered about 3 a.m., owing to the passage of the cyclone's trough, the diurnal variation superimposed on the general direction is, in spite of many irregularities, sufficiently obvious.

Take the average of a number of observations of the velocity of the wind for every hour of the day, the changes due to alterations of cyclonic gradients will be eliminated, and only the mean velocity, with a diurnal variation superimposed, will be left.

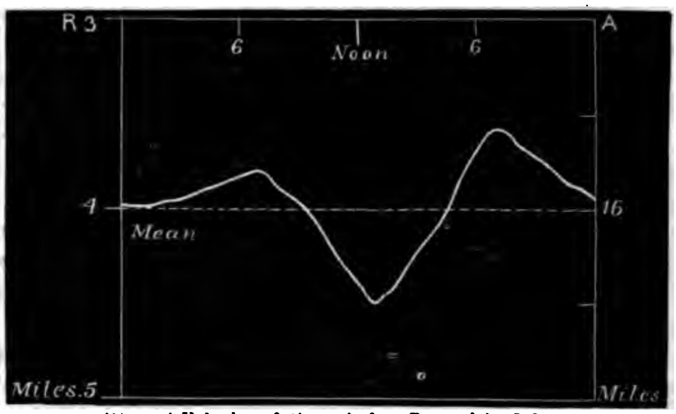
Performing this operation in Great Britain, not only will a principal maximum be found about 2 p.m., and two nearly equal minima during the night with a small maximum between them, common to almost the whole world, but also a series of smaller or minor local variations, which have been thus summed up by Mr. Ley, in the *Quarterly Journal*, Vol. III. p. 284, for Stonyhurst, from the tabulations of the Meteorological Office :—

"The general character of the mean diurnal variations of velocity, as these occur at the stations in the British Isles, may be fairly inferred from mean horary velocity curves, and may be thus described :—At the inland stations, *in summer*, a slight increment of velocity occurs about midnight. This is succeeded by the morning minimum, which takes place in most of the months examined a little after sunrise. The mean velocity then rises until 1 p.m., when the diurnal maximum is sometimes attained. A slight subsidence then commonly occurs, but the mean velocity rises again at 3 or 4 p.m., and this second increment frequently forms the diurnal maximum. A great fall then takes place, which is more rapid than the rise in the morning; and the evening minimum, which is in most months the diurnal minimum, is attained about 10 p.m. The mean velocity at 1 p.m. is, in fine and hot weather, more than double the 10 p.m. velocity in miles per hour, and exceeds the diurnal mean by about one-third. *In winter* the inflexions are very greatly modified. The midnight rise is not in all months traceable, and the subsequent diminution is not very great. The morning maximum occurs about sunrise. The diurnal maximum takes place

about 1 p.m., is less than double the minimum in miles per hour, and exceeds the mean of the day by about one-fifth only."

In fig. 7 is given the head of the diurnal velocity curve at Sandwick Manse, Orkney, as deduced by Robinson's method, by Mr. J. S. Harding, Junr.,* in which the velocity is measured from the top of the diagram, so as to compare with the Kew anemograms just given; the figures on the left-hand side, marked R, being the values of the resultant wind from which the diagram is constructed; while on the other side, marked A, the mean arithmetical value of the wind's velocity is also marked. This shows the principal maximum at 1 p.m.; but the two nearly equal minima occur about 7 a.m. and 7 p.m., probably owing to the high latitude.

FIG. 7.



Diurnal Velocity of the Wind at Sandwick, Orkney.

This means that if there were a stationary and unchanging cyclone, the wind velocity at every part would be that due to the isobaric gradient, modified at every hour by the variations shown in the curve; and as this curve applies to all weathers, the same argument would hold good for anticyclones, or any other distribution of pressure.

FIG. 8.

Diurnal Variation of the Wind at Sandwick, Orkney.

Similarly, if the average direction were ascertained from numerous observations for every hour, the result would be the mean direction of the wind geometrically, with a diurnal variation common to all winds superimposed. In fig. 8 is given the curve of diurnal wind variation in Orkney, by Robinson's method, from the paper above quoted. From this it will be seen that after 1 a.m. the wind veers till 7 a.m., then backs a little till 10 a.m., when it veers to its maximum at 3 p.m., after which it backs to its minimum about midnight; and the same argument as before would hold good, that for any unchanging distribution

* *Quarterly Weather Report of the Meteorological Office*, 1871.

pressure the direction would be that due to the shape of the isobars, lified at each hour by the diurnal variation.

t also follows, from the general laws of wind circulation, that in a cyclone wind will be more incurved, and in an anti-cyclone more outcurved, by ht than by day.

Popular weather lore has several allusions to diurnal variations of wind. Greek myth that the four winds are the children of Astraios and Eos, t is, of the starry heaven and of the dawn,—as also the Scotch saying t "the west wind is a gentleman, and goes to bed,"—both refer, in the gery or phraseology of their respective civilisations, to the rise and fall wind with the day.

A well-known prognostic says:—"It is a sign of continued fine weather n the wind changes during the day, so as to follow the sun." This ans that when the wind veers during the day, in the manner which has been described, it is either the sign of an anti-cyclone which is always ompanied with settled fine weather, or else of a cyclone of such derate intensity that no rain need be expected. But this prognostic, also, n fails, because, even during cyclones of considerable intensity, and ompanied by rain, a certain amount of veering with the sun is often erved. Considering all the diagrams given in this paper, it will be seen that optic charts at every hour not only give in plan the general changes of ssure and wind with great clearness, but also all the diurnal changes, ugh these latter appear in such a manner that minor fluctuations ght easily be overlooked. Also that the continuous curves of anemophic instruments indicate in section both the general and superimposed rnal variations with great ease and accuracy, but that the two can only be arated approximately for any particular day; and finally, that a curve of rage wind gives the diurnal variation of velocity and direction with the atest clearness and accuracy, but that all the meaning and effect of eral changes is lost.

Thus, not only can the meaning of each class of observations be seen, the observations connecting wind with the time of day which have been de from the earliest ages, and which were systematised by meteorologists the school of Kämtz, can be collated with the more recent discoveries of relation of wind to the shape and position of isobaric lines.

Turning now to the diurnal variation of weather, in figs. 9, 10, 11 (p. 220), given in a diagramatic form the position of cloud and rain in a typical clone of pretty constant shape and gradients in the United States on January th, 1878, at 11 p.m., and on the 21st at 4.35 p.m. and 11 p.m., being the ne cyclone whose winds have already been discussed.

From these it will be readily seen that the area of rain and cloud round centre in the first 11 p.m. chart is considerably increased, relatively to centre, in the 4.35 p.m. chart, and again diminished in size in the second p.m. chart. This indicates that it rains in more places during the day n during the night, and therefore, in a general way, that in countries ere the rainfall is principally associated with cyclones rain will be more quent by day than by night.

Fig. 9.

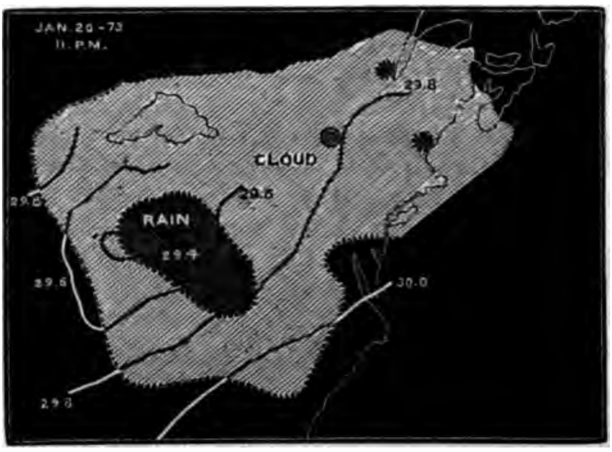
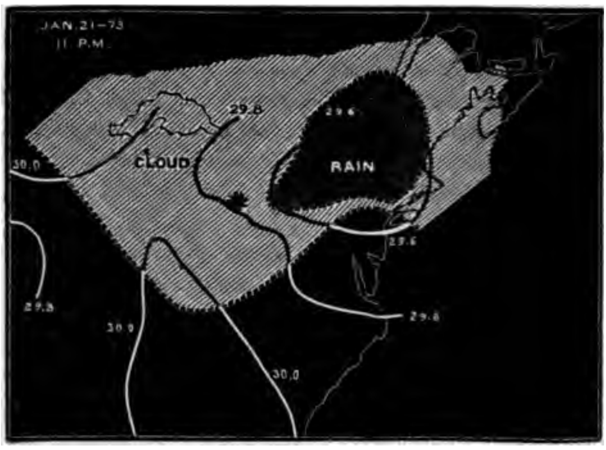


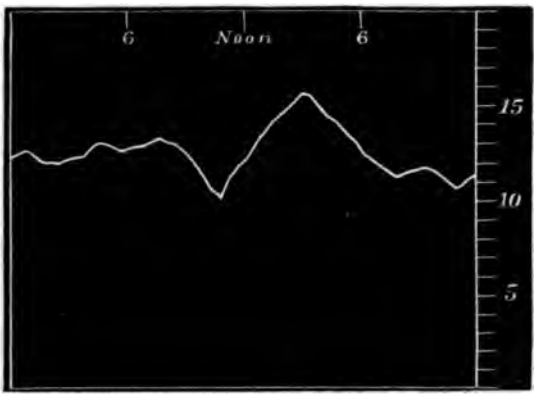
Fig. 10

Fig. 11.



Where hourly observations are taken, it is very easy to construct a curve the comparative frequency of rain, independent of the amount, at each ır of the day. Fig. 12 represents such a curve for Greenwich, drawn m the results given by Mr. J. Glaisher in his paper on "The Frequency of in."* By this it is very evident that, broadly, most rain falls between the ırs of noon and 5 p.m., with several minor fluctuations, and the same ument holds as for wind, so that in a stationary and unchanging cyclone rain area would expand and contract at the different hours in a manner

Fig. 12.



Diurnal Frequency of Rain at Greenwich.

portional to the mean frequency of rain. The minor fluctuations appear vary a good deal in different months, but the well-marked diminution of n between 10 and 11 a.m. is common to all.

This means that in the course of any cyclone there will often be a nporary clearing between 10 and 11 a.m., a phenomenon which must be niliar to any close observer of cyclone weather. It also affords an explaion of the following curious prognostic, which is widely believed in the rth:—"There are what are called good and bad hours of clearing. If weather begins to improve about noon or 3 p.m. it may be expected to ntinue better; but if it clears at 11 a.m. or 2 p.m. the improvement is only nporary." This implies that if the weather improve about noon, in te of natural diurnal increase, the cyclone is probably passing off; and t 3 p.m. the gain will continue, either from diurnal diminution of a not y intense cyclone, or from the passage of the cyclone. On the other hand, significance of the 11 a.m. clearing has been seen, but I cannot explain y a clearing about 2 p.m. should not hold.

It must specially be observed that though the principal rainfall in Great tain is cyclonic, there are many countries in which the bulk of rainfall urs during thunderstorms, either in anticyclones, or still oftener in the row of low pressure which lies between two adjacent anticyclones. I cannot what the diurnal variation of rain is in these types of pressure, but the

* *Proceedings Meteorological Society*, Vol. IV. p. 83.

same argument holds good as in cyclones—that the diurnal increase of rain shown on synoptic charts, for any shape of isobarics, is reflected in the curve of mean diurnal frequency of rain.

It is very evident from all the examples which have now been adduced, that diurnal wind and weather are both totally independent of the general changes on which they are superimposed, and I have elsewhere shown, in my paper on "Harmonic Analysis,"* not only that the diurnal barometric changes are similarly superimposed, but also how they may sometimes be approximately measured ;† and the same may also be shown with regard to temperature.

In anticyclones in this country, and normally in the tropics, the general changes are so small that the diurnal changes really constitute the observed weather ; while in cyclones in this country and the polar regions, as a whole, the general changes are so great that the diurnal changes are almost or entirely masked. Hence the fundamental principle, that the diurnal and general changes are independent, and that the observed weather represents their sum, holds all over the world. This is of great importance for two reasons. In the first place, it explains many meteorological questions, and helps to classify a large number of weather phenomena; while in the second place, since it is evident that in dealing with a large mass of observations, the diurnal variations may safely be eliminated, the road is greatly cleared and simplified for further research into the general changes on which all weather forecasting depends.

So far I have confined himself exclusively to observed facts; but I now wish to point out a simple hypothesis, by which diurnal veering of the wind and the increase of rain follow naturally from the diurnal increase of wind velocity.

Assuming the ordinary trade-wind explanation of the wind's rotation, it is manifest that in a cyclone a south wind at 4 a.m., moving at a rate of 10 miles an hour, would have a smaller component to give out than the same wind at 1 p.m. with a velocity of say 20 miles an hour, and a vane exposed to its influence would therefore veer a little towards the west during the day. Also, since a cyclone wind is always a little incurved, if the shape of the isobars remained unchanged, the wind would be more incurved by night than by day. Similarly for a south wind in an anti-cyclone, as it is always a little outcurved, the outcurvature would be greater by night than by day; and the same argument would hold for every other direction of the wind.

Then as to the increase of rain. Since the wind is stronger by day, a larger volume of air will be poured into the cyclone than at night, in spite of the diminished incurvature. The ascensional current required to counteract this inflow will therefore be greater, and the area of rain and cloud increased. Conversely in anti-cyclones the descending current in the centre is stronger by day, and the sky therefore clearer, as is always observed.

Since cyclones and anti-cyclones may both be considered as complex

* *Quarterly Journal*, Vol. IV. p. 141.

† *Ibid.* Vol. IV. p. 198.

vortex rings, and as they often remain unchanged for many days, the general view here suggested is that as the sun rises on any existing weather-systems, it neither makes nor changes them, but merely increases the velocity of the circulation within them, and that the veering of the wind and increase of rain follow as a necessary consequence.

The results of this paper may be summarised as follows:—

By constructing synoptic charts at different hours of the same day, and by comparing the wind and weather records at the different hours, and examining their relation to mean curves of diurnal variation, it is shown:—

1. That the mean diurnal increase of the wind's velocity is explained by the fact that for the same gradient there is more wind by day than by night.

2. That the mean diurnal veering of the wind is explained by the fact that in cyclones the wind is a little more incurved and in anti-cyclones a little more outcurved, by night than by day.

3. That the mean diurnal increase of the frequency of rain during the day hours, in countries where the bulk of the rainfall is cyclonic, is explained by the fact that in any given cyclone the area of rain is larger by day than by night.

For every element it is shown that the diurnal changes are superimposed on the larger general changes, and that they are independent of each other. Great stress is laid on this point, both as explaining and classifying many meteorological questions, and as simplifying the problem of weather forecasting.

A simple hypothesis is suggested, from which it appears that the diurnal veering and increase of rain follow as a natural consequence of the diurnal increase of velocity.

DISCUSSION.

Professor ARCHIBALD said he felt bound to make some objections to the hypothesis put forward to account for the diurnal change in the direction of the wind. He believed the facts brought together by the author were correct, and, as far as they went, useful in showing diurnal changes in plan. He was, nevertheless, surprised that the author should deem it necessary to italicise such an obvious platitude as that "the resultant wind during any day is the sum of the general and diurnal variations," and to find the same principle referred to throughout the paper as if it were an original discovery of great importance. The author endeavoured to explain the diurnal variation in the direction of the wind as an immediate consequence of the diurnal variation in its velocity. As the wind increased in velocity, so, according to the author, if it possessed any meridional component, it ought, according to the ordinary Trade Wind theory, to be more deflected in an east or west direction by the earth's rotation. This conclusion was evidently incorrect, as the deflecting force must vary with the velocity of the current, and so the ratio of the eastward component to the northward component in the case given by the author remained constant. The direction of the resultant would therefore remain unchanged, though its magnitude would be increased. He thought the explanation given by the author was not only intrinsically unsound, but regretted to find the ordinary Trade Wind theory appealed to, which only accepted the deflection due to terrestrial rotation for motions having meridional components, and entirely overlooked the fact, as proved by Ferrel and others, that owing to the nearly spherical shape of the earth, the deflection was just the same for motions in all directions. But, even admitting for the sake of argument that such a change of direction as the author assumed might take place, there was a cardinal objection to the statement that the diurnal period in the wind's direction was directly connected with the diurnal period in its velocity, since it had been clearly shown by Dr. Köppen,* in a paper entitled

* *Zeitschrift für Meteorologie, Band XIV.* 1879, *Sept. Heft.*

'Ueber die tägliche Periode der Geschwindigkeit und Richtung des Windes,' from a discussion of the winds at Vienna and elsewhere, that the maximum diurnal velocity for winds from all directions occurred about noon, while from Dr. Nachtigal's observations in the Sahara and others in the Trade Wind regions, where the diurnal change of velocity was very large, there appeared to be no appreciable corresponding change in direction. The diurnal change in the wind's direction was, moreover, subject to local influences which did not affect the diurnal change in velocity, and which in some cases, such as at Upsala and Zi-ka-wei, where the sea lay to the east, completely inverted the ordinary rotation, and caused the wind to blow from the west in the morning and the east in the evening. Mr. Abercromby stated that the mean diurnal increase in the wind's velocity was explained by the fact that for the same gradient there was more wind by day than by night, but Professor Archibald regarded such a conclusion as merely amounting to an equivalent substitution of fact for fact. The latter fact, however, namely, the diurnal variation of the ratio velocity in respect to the gradient, was not only confirmed, but satisfactorily explained by Dr. Köppen in the article already alluded to, where he showed it arose from the intermixture of the air (Luft-austausch). This naturally took place more readily between the different layers of the atmosphere during the day, and which caused the horizontal velocity of the entire mass of air to be more uniform, the lower layers borrowing a higher velocity from intermixture with those above, and, similarly, the higher layers a slower motion from those below. This explanation agreed with wind observations at different heights, and with the values found by Mr. Ley for $\frac{V}{g}$ in winter and summer. They likewise accorded with the diurnal change in the humidity at different elevations as shown by Dr Köppen.

Mr. C. Harding thought that the conclusions arrived at in the paper were based upon insufficient data; as an instance of this he referred to the reasoning followed by the author with regard to the decrease in the area of rain round the centre of low barometric pressure, said to be shown between 4.35 p.m. and 11 p.m. by the Charts of the United States Signal Service; but by looking at these charts it would be seen that the one for 11 p.m., January 21, 1873, showed that the area of low pressure was entering the Atlantic, and since the author in a previous paper demonstrated that the rain area in a depression was most marked in the front, it was evident in this case that nothing could be known as to the size of the rain area, since the front of the depression was situated over the Atlantic, where, it might be presumed, no observations existed to reason upon. The method of discussion followed by Mr. Rundell with the Liverpool winds* was unique, for although somewhat similar to that pursued by Mr. Chambers, yet there was an important difference, insomuch as Mr. Rundell, in computing the diurnal inequality of the wind, subjected the observations to the harmonic analysis, and followed up the discussion with each term of Bessel's expression, treating the polar or semicircular coefficient separate from the quadrantal and so on. The wind components of each term were then laid off, forming an ellipse, the variations in which exhibited in the most evident manner the variations of the wind. Mr. Harding also remarked that he believed there were exceptions to the direction of change as laid down by the author, and referred to Ascension as an example of this, the SE Trade there becoming a few degrees more southerly in the day than in the night.

Mr. Rundell considered the data used in the paper rather weak when compared with the deductions made from them, and even some of these were merely local and could not be accepted as generally correct. For instance, the conditions at Liverpool were quite opposite to what the author had stated as general conditions, the east winds there being stronger by night than by day, whereas at Plymouth east winds were stronger by day than by night. With regard to the diurnal variation in rainfall, Mr. Baxendell, he believed, had shown that in the neighbourhood of Manchester the early hours of the morning were the most rainy, and that the least rain fell between 8 and 11 a.m. It was rather remarkable that the author had not referred either to Mr. Chambers's discussion of the winds at Bombay, or to his (Mr. Rundell's) paper on the winds at Liverpool. Both investigations showed that the diurnal variation in the direction of the wind was not the same throughout the year, the changes at one part of the year

* Quarterly Weather Report of the Meteorological Office, Part IV., 1874.

being with the sun and at another part in the opposite direction. The plane of rotation seemed to be nearly vertical, and to be inclined to the south during one part of the year and to the north during the remaining portion. A change of this kind would perhaps explain the difference between an apparent current movement in opposite directions when that direction was measured only on a horizontal plane near the earth's surface.

Mr. SCOTT remarked that the diurnal range of rainfall determined for Greenwich would not suffice for the explanation of periodical phenomena elsewhere. In the recent paper on the Rainfall at Cherrapunji it had been stated that the fall by night was twice that by day, a result differing from the Greenwich values. Dr. Hann and Professor Augustin had recently published discussions of the rainfall range for various stations in Europe, such as Vienna, Prague, &c. They found that the curves usually exhibited 3 maxima and 3 minima, but the course of that for Berne was nearly exactly opposite to that of the other stations examined, giving a strongly marked minimum about 1 p.m. The subject required much more examination.

Mr. SYMONS thought that it might be well to direct the attention of the Fellows to a discussion of the wind of Wrottesley, Liverpool and Birmingham by Mr. A. F. Osler, printed in the *British Association Report* for 1865.

Mr. EATON remarked that at the more northerly of the first-order stations of the Meteorological Office, such as Aberdeen, the hourly records of rainfall were greatly interfered with by snow. The relative frequency and ratio of the rainfall including snow could not be ascertained by the existing apparatus.

The PRESIDENT (Mr. Laughton) said that all workers on meteorological problems would recognise the value of synoptic charts, which the author had already applied to important deductions relating to cyclonic weather. There seemed, however, one very great difficulty in the way of using them, as suggested in the present paper, for comparison of diurnal changes: the charts must either be of limited extent, in which case the range of observation was too small, or the question of local time entered into the consideration and necessarily distorted the results In the charts which the author had referred to, the difference of local time between the east and west borders was some 4 or 5 hours: the times indicated on them were, he believed, Washington times, and could have no diurnal reference to the weather as shown in the more westerly, or indeed in the more easterly districts. That wind did change with the daily march of the sun was not to be doubted: but the particular manner of the change was probably, in many instances at any rate, directed by local causes, which must be more clearly understood before any general rule could be laid down.

Note.—The following remarks have been supplied by Mr. Abercromby (who was unfortunately prevented by indisposition from being present at the meeting), after perusal of the foregoing notes of the discussion.

Mr. R. ABERCROMBY in reply upon the discussion pointed out that objection had been taken to the suggestion that diurnal veering followed from diurnal increase of velocity by the ordinary Trade-Wind theory, on the grounds that the ratio of the eastward to the westward component would remain constant, and that, therefore, the direction of the resultant would remain unchanged. In a free moving body this would probably be the case, but in practice the author believed that a larger portion of the eastward component would be wasted when the wind moved slowly than when it moved quickly. Take also that portion of a cyclone where the wind was from the south, at the time of day when the diurnal variation was *nil*; then alter the velocity diurnally, and it seemed certain that the balance of the wind's direction would be also altered, and it was difficult to see how the change could be independent of the velocity.

Reference had been also made to the influence of local causes in modifying diurnal changes, which could only be profitably considered by taking each case on its own merits; and also to land and sea breezes, which were a diurnal variation of a totally different class to that discussed in the paper. The author originally intended to have added an account of his researches into the relation of the old heating theory of land and sea breezes to the modern discoveries of the relation of wind to isobars, but afterwards thought it better to reserve it for a separate communication. The result might, however, be stated here, that in this country, at all events, when the general gradients were slight, the differ-

ence of diurnal barometric variation over land and sea, probably due to unequal heating, sometimes locally inverted the gradient at certain hours of the day.

Allusion had been made to Dr. Köppen's theory that the diurnal variation of velocity was due to the admixture, more readily by day, of the upper and lower layers of the atmosphere, the former being supposed to have normally the higher velocity; but the author could not accept this suggestion, as he had often observed much surface variation when the upper currents were not only going slower, but even in an opposite direction. In drawing up the paper, besides personal observation, the principal *data* respecting the wind were derived from the *Quarterly Weather Reports* of the seven British observatories for all the years which had been published, which all showed the same main features of wind variation. For cyclone weather the author had relied almost entirely on his own observations, extending over the last 14 years, during which he had always taken special care to learn from synoptic charts that the rain and weather were really cyclonic and not due to other forms of pressure distribution.

Mr C. Harding thought that Fig. 11 failed to show the diurnal decrease of rain area owing to want of observations, but this is not the case. It would be seen by the dotted line that the rain area was all observed, and that in the cloud area a dotted line was drawn only round that portion where the observations were complete, so that no serious error could arise. No doubt it was difficult to allow for local time in synoptic charts generally, but in the present case the observations extended over about two hours of longitude, while the rain area in no case extended over one hour, so that for the latter the influence of local time might safely be neglected, though it was not improbable that, in the first chart, some of the great extension of cloud to the north-west was due to the radiation of a cold winter night and not to the cyclone.

With regard to the fact that at Ascension the wind veered with the day, although that island was situated in about lat. 8° S, at the edge of the persistent anticyclone, which gives rise to the SE Trades, no deduction could be made from a single station, but if it should ever be observed that in the southern hemisphere generally the wind normally veered with the day, the inference would be that in cyclones the wind was more incurved and in anticyclones more outcurved by day than by night, since the rotations there were opposite to those in the northern hemisphere.

Much notice was taken of Mr. Rundell's elaborate reductions of the winds at Liverpool; but while fully recognising the care, skill and labour with which they had been carried out, the author thought the method employed only partly showed diurnal variations. First, consider the results. These were that east winds (the land winds) were stronger by night than by day, and that while in winter, spring and summer the wind veered with the sun, in autumn it turned in the opposite direction. It was impossible to explain this certainly without reference to the original records; but considering that at Stonyhurst, distant 40 miles NNE from Liverpool, Mr. Ley had found no difference in the general character of the diurnal velocity of east and west winds, and that no trace of abnormal veering in the autumn months was to be found in the records of that station, it could only be concluded that there was some source of local variation at Liverpool. From data which had been courteously supplied to him by Mr. Rundell he suspected that it was due to the influence of land and sea breezes. Consider now the effect of this on a statistical curve. The theory of averaging implied that the general variation having been balanced out, there was only one diurnal source of variation left; but if there were two, they got mixed up in the resulting curve, which thus ceased to have any physical significance, and merely represented the arithmetical sum of the numbers. If any single day had been considered, no such error could ever have arisen, and the process of averaging had introduced rather than eliminated error. If no deduction could be made from the wind-curve when plotted, it was also manifest that no geometrical expression for the curve—for instance, a harmonic series—could have more significance, and it could not therefore but be doubted whether the harmonic constituents of the winds at Liverpool, so carefully worked out by Mr. Rundell, had more than a geometrical meaning.

Mention was made of the fact that at Bombay the wind veered with the sun at one season of the year, and backed at another. Of course, being neither cyclonic nor anticyclonic, these winds did not come within the scope of this paper, but he believed that they were due to the influence of land and sea breezes on the two monsoons.

Considerable criticism had been directed to the statement that rain was more quent by day than by night, apparently from the misapprehension that the ırnal course of rain was the same in all shapes of isobars, and that the ncipal rainfall in every country was cyclonic. This was very far from being case. The fundamental principle of all synoptic meteorology was that every ape of isobars not only had a characteristic wind and weather, but also a ecial diurnal variation, and there were many parts of the world where there re no cyclones, but abundant rainfall. The paper only professed to describe e variation in cyclones, and the impress which they left on the curve of rain quency. He believed that in this country the bulk of the rainfall was cyclonic d that it followed the course described in the paper. The only apparent ception which he had observed was in a common type of large winter cyclone the west coast of Scotland, when the wildest weather was between 2 and 8 n., but he had reason to think that in this case the gradients were steeper in e early morning, so that it was hardly a case of true diurnal variation.

As to non-cyclonic sources of rain in this country, rain fell: (1) in anticlones, but very rarely; (2) in V shaped depressions, mostly in summer time;) with straight isobars when the gradients were very steep; (4) in some kinds thunderstorms; (5) in the furrow of low pressure between two adjacent ticyclones; and probably (6) in a small class of secondary cyclones in the early orning, associated with the prognostic—

> "Rain at seven, fair at eleven;
> Rain at eight, fair late."

his meant that if it came on to rain about 7 a.m. the rain, not being cyclonic, ould probably not last long, while if it came on about 8 a.m. the rain belonged a true cyclone and would probably last some time. He was unable to say hat the precise nature of the diurnal variations were in each of these cases, it they were undoubtedly different from the variation of cyclones.

Consider, then, the genesis of a statistical curve of rain frequency. In it ere were added together several distinct variations, so that the result was to a rtain extent only arithmetical, and did not represent absolutely any one; ough if one was much stronger than the others its impress would be the most vious. Now this was exactly what appeared to be the case in the Greenwich rve. The curves for the separate months, given in Mr. Glaisher's paper, differed much from each other that it was only when the whole year was taken that the edominant cyclone influence was unmistakably seen, and it seemed probable at the minor fluctuations had only an arithmetical significance. The only other in curve he had seen was that for Brighton, which presented the same features the main as the Greenwich one. It must be remarked that a cyclone rain rve took longer to average than any other diurnal phenomenon, as it was necesry to balance both the time of day and the distance from the centre. For this ason the curve for near Manchester, given by Mr. Baxendell, was of little value, it was derived from only 8 months' observations.

Much light had been thrown on this part of the subject by the researches of rof. Dr. F. Augustin, of Prague. He had described the yearly rain curves at erne, Vienna and Zechen, which all showed the same broad features of two rincipal (morning and maxima evening), with well marked day and night inima with smaller variations. Mr. Abercromby was unable to say anything out the Austrian stations, but, from a slight knowledge of Swiss meteorology, e could positively state that the principal rainfall there was not cyclonic, though e was unable to say what those rain conditions were. When the weather there as truly cyclonic he had observed the diurnal increase of cloud to be very arked. Dr. Augustin also gave the rain curves at Prague, not only for the whole ear, but also for the four seasons. The results were very interesting. In winter, mitting minor flexures, there was a principal maximum about noon, with two maller ones in the morning and evening; in spring and autumn two (morning nd maxima evening) with day and night minima; while in summer, the curve ose from an irregular minimum between midnight and noon to two nearly equal axima about 4 and 8 p.m.

Now, when these were combined into a yearly curve, it would be found that he rain rose from a minimum at 3 a.m. in a very irregular manner to a maximum t 8 p.m., from which it again declined. This signified that an evening maximum, eing common to each season, remained a constant feature, while the other

flexures were only the arithmetical balance of the variable features of the different seasons, from which no physical deduction could be safely drawn. From observations in the Rhine valley, there was reason to believe that the morning and evening maxima were probably due to anticyclonic thunderstorms, and that the difference in the seasons was due to the recurrence of different types of weather in different months.

It was very evident from all the examples both of wind and weather which had here been given, that the statistical method failed when there was more than one diurnal variation to eliminate, as the method actually mixed such different conditions as land and sea breezes with normal wind veering, and cyclone rain with anticyclonic thunderstorms, which could never occur together in any one day; and he therefore believed that the method of taking a number of well-defined cases of any shape of isobars, and of which an example was given in the paper, was the line of research calculated to afford the most satisfactory results.

A NEW METAL SCREEN FOR THERMOMETERS. By the Rev. FENWICK W. STOW, M.A., F.M.S.

[Read June 21st, 1882.]

It has been pointed out by meteorologists on the Continent that metal, and not wood, is the proper material for thermometer screens. It is not intended to argue that question, but the result of a comparison between a screen with zinc louvres and a Stevenson screen of the ordinary pattern may, perhaps, prove of interest to the Society.

The screen in question differs from the ordinary Stevenson screen in the following respects:—

1. It is somewhat larger, being 2 feet long, 18 inches wide, and 2 feet high, exclusive of the roof; the corresponding dimensions of the Stevenson screen being:—Length 18¾ inches, width 11 inches, and height 18 inches.

2. It has a single set of double zinc louvres instead of a double set of ordinary wooden louvres; these zinc louvres being bent to a right angle down their length.

3. It is partially closed at the bottom to cut off radiation from the ground.

4. It has a double instead of a single roof.

The details of its construction are given in the Appendix (p. 234). It may suffice here to say that the outer portion of each louvre is 2 inches wide, and the inner part ¼ of an inch. The clear space (or perpendicular distance) between the louvres is ⅝ inch. The number of louvres was 100, and these were supplied by a tin-smith cut to the exact lengths and bent as required for 18s. 4d. Probably in a town they would cost less. The carpenter's work is all of the simplest character. The outer parts of the zinc louvres are set at an angle of 30° with the vertical.

The following advantages are claimed for the use of zinc louvres:—

1. The conductivity of metal causes the heat derived from the sun's rays to be distributed over every part of the louvres. Supposing, as in the screen in question, the surface on which the sun's rays fall when it is shining vertically on the louvres, is only one-tenth of the entire surface of each one of them, it is evident that when the heat received upon that small surface is distributed, it becomes almost inappreciable.

2. The louvres being much thinner than those of wood, the circulation of ir through the screen is not only much greater absolutely, but much greater lso in proportion to the bulk of the louvres. Hence,

3. The zinc louvres are much more sensitive to changes of temperature han wooden ones—more sensitive, indeed, than the bulbs of thermometers. 'hey do not, therefore, appreciably retard the transmission of a wave of emperature into the box.

The comparison of the new screen with an ordinary Stevenson screen, ought some years ago in Edinburgh, was by no means complete or exhaus- ive, for the following reason :—The general character of the weather at the ime was wet and windy, and it was impossible therefore to observe what ould occur under the extreme conditions of cloudless heat and calm, when he divergence between different forms of screen is usually greatest. There , however, this advantage in unsettled weather, that the frequent changes hich occur give a considerable variety of conditions under which the trials re made.

So far, then, as the weather permitted, it was attempted to make the periments complete. The author has no belief in the mere multiplication f observations. Unless the meteorological conditions under which every bservation is made are carefully noted and taken account of, the results nnot be of much value, and may be altogether illusory. Mean results in hich agreement is the balance of opposite errors, are very frequently found investigations of this sort. And if means are simply taken of observations ch errors cannot be detected, and, consequently, years of observation may o for nothing.

Precautions were, therefore, taken to make the few observations possible ally trustworthy. The two screens were placed east and west of one nother, only just far enough apart to prevent one from shading the other at ny time; they were so placed that the bulbs of the dry and wet bulb thermo- eters were exactly 4 feet from the ground; and the instruments used were refully compared, both before the observations commenced and after they ere completed. Then the direction and force of the wind, the amount of loud, and the initial letter for the weather at the time of each observation nd previously, were recorded, and also whether the sun was shining at the me or not.

Although in meteorology given conditions under which experiments are to e made by careful observation cannot be produced at will, it is possible so far approximate to a correct knowledge of the actual conditions, as to be able rely on the law that the same result must necessarily recur under the same onditions. For experiments of this sort one good observation is worth as any as a thousand, and observations are repeated only to obtain assurance hat the conditions of experiment were correctly noted. The author found hat, after a certain number of observations had been made, he could, after bserving the meteorological conditions, predict from the reading of one hermometer what the others would indicate with a tolerable degree of ccuracy.

At the same time experiments were carried on with an old wooden screen which had been in use for some 12 years (8 feet 6 inches long, 1 foot 6 inches wide, and 22 inches high in the centre), and which may be considered a fair specimen of a large and convenient double-roofed and double-louvred screen. It stood about 28 feet N of the Stevenson and zinc screens, 22 feet from a SE wall, and 26 feet SW of the west corner of the house, the shadow of which sheltered it till nearly 9 a.m., whereas the Stevenson and zinc screens were 37 feet and 41 feet respectively SW of the house, which was the nearest object. In giving the figures for this wooden screen, it must be distinctly understood that the comparison by no means attained the same degree of accuracy as that between the Stevenson and zinc screens. The 9 a.m. observations, in particular, were comparatively too low, on account of the shadow of the house, which at that hour had only just cleared off; but, as on the whole the position of the screen was nevertheless better than the average of those adopted at our public observatories, its readings have been retained, which at all times except 9 a.m. may fairly be compared with those of the Stevenson and zinc screens. They show, it is true, occasional local irregularities, from which the comparison of the Stevenson and zinc screens is free, or nearly so; but on the whole they are not untrustworthy.

With regard to instruments, the principal dry and wet bulb thermometers in the zinc screen had cylindrical bulbs, the check thermometers (lent by the Meteorological Office) spherical bulbs. Those in the Stevenson and the old wooden screen had spherical bulbs of 0·35 inch diameter. No observation was accepted if the cylindrical and spherical bulb thermometers in the zinc screen did not agree exactly, but another observation was taken a few minutes afterwards. In observing, the author always returned to the screen in which the thermometers had been read first, and if any change had taken place, the thermometers in both were read again, and sometimes even a third or fourth time, till it was satisfactorily ascertained that there was no local or accidental irregularity, at least as regards the Stevenson and zinc screens.

The maximum thermometer in the Stevenson screen was by Negretti and Zambra, with a bulb of 0·4 inch diameter. That in the "Zinc" was by Casella, and the bulb was slightly smaller. They were not, however, equally sensitive. The Phillips' maximum, perhaps from all wood having been cut away from the bulb-end, rose to the correct temperature when brought into a warm room in 15 minutes, while the Negretti and Zambra took 25 minutes. This may partly account for the excess of the maxima in the first series of observations being less than that found by eye observation at 2 p.m., a result which may also in part be attributed to the greater facility with which waves of heat find their way into the zinc screen. The maximum, being of course the summit of a wave, may be even higher in a cooler screen which admits heat-waves of larger extent.

For the minimum a verified spherical-bulb spirit thermometer was used in each screen. In the zinc screen there was, in addition, a sensitive spirit minimum with forked-bulb, and in the Stevenson screen a mercurial mini-

mum, which when in the same screen with the former always agreed with it. Another good mercurial minimum was in the old wooden screen. The readings of the spherical-bulb spirit thermometers are those given in the tables, except where the more sensitive thermometers showed that there was some decided error. But the readings of maximum and minimum thermometers, however useful in ordinary observations, are scarcely susceptible of the minute accuracy aimed at in these experiments. They must not be considered as of equal value with eye observations. In the second series of experiments a third maximum, also by Casella, was brought into use, and the three were constantly interchanged. In this series, therefore, the instrumental errors due to differences of sensibility may be considered to have been eliminated, or nearly so.

Thus prepared, regular observations were taken from July 23rd to August 17th, 1881, of the dry and wet bulb thermometers at 9 a.m., 2 p.m., and 9 p.m., and of the maxima and minima. All the observations were corrected as they were set down, and the dew-point calculated for every observation of the dry and wet bulb thermometers, by Glaisher's "Hygrometrical Tables" (2nd Edition).

During this period, out of 25 observations at 9 a.m. only 4 were taken in bright sunshine, and 7 with the sun partially visible; of 22 at 2 p.m. 12 were taken in sunshine, but only on 7 days had the weather been fine for an hour or two previously. There was no day on which any screen could have been much heated by the sun.

It is not surprising, therefore, to find the differences small. At 9 a.m. there was no difference between the Stevenson and zinc screens on eleven days, but 9 of these were cloudy or wet, one other partly overcast, and on the remaining day the sun had only just come out. The average difference was 0°·14, but on the 7 fine mornings the average was 0°·3, and on one day it amounted to 0°·6.

On the 4 days when the wind exceeded 4 on the Beaufort scale, the average difference was only 0°·05. On only one of the 25 days was the reading in the zinc screen higher than in the Stevenson at 9 a.m.

At 2 p.m. the thermometer in the Stevenson screen was higher than in the zinc screen by 1° on one day, 0°·9 on another, 0°·7 on two days, 0°·6 on one, 0°·5 on two days, making seven days on which the difference amounted to or exceeded 0°·5. On five days there was no difference, but these days were all cloudy or wet. On no day was the Stevenson cooler than the zinc screen at 2 p.m. The average excess was 0°·3, but on 14 fine or moderately fine days the average excess of heat in the Stevenson screen above that of the two other screens was 0°·5.

At 9 p.m. the difference was generally *nil*, and the average difference was only 0°·02. The thermometer was lower in the Stevenson screen 6 times, and in the zinc screen 4. But for one difference of 0°·6, there would have been no difference on 24 evenings greater than 0°·2. That single divergent reading, however, was corroborated by the calculated dew-point being the same in both screens.

It appears, then, that while in cloudy or wet weather there was scarcely any difference at any hour of the day, there was a distinct tendency in the Stevenson screen to give higher readings than the zinc screen whenever the sun shone. The dew-point, however, was practically the same in both screens, however different the readings of the dry bulb thermometers were.

It seemed that the tendency shown by the Stevenson screen to give higher readings when the sun shone, required further investigation. If, of two screens, the one which allows changes of temperature to be more quickly transmitted to the thermometers is nevertheless found to give the lower reading, it is a fair conclusion that that screen gives the nearer approximation to the true temperature of the air. The zinc screen could not well give a temperature lower than that of the air, and the amount by which the Stevenson screen differed from it during sunshine (while agreeing exactly with it at night, and during cloud or rain), could hardly be anything else than an error due to the heat of the sun.

The author thought it desirable, therefore, to make a few special observations in fine weather. But before entering upon any crucial experiment both screens were painted. Hitherto the zinc louvres had remained unpainted, the woodwork alone having received one coat of paint, and the paint on the Stevenson screen was in the condition to which some years of exposure had reduced it. Both were painted outside with three coats of white paint, only the wooden framework of the zinc screen was painted dark red for ornament. The roof, and as much of the zinc louvres as was visible from without, was all white. The author, however, does not believe that the painting made any difference.

Proceeding with the experiments, on the 5 bright mornings on which observations were taken at 9 a.m., the Stevenson screen was on an average more than 0°·5 warmer. On 2 of these the air was calm, and the differences were 1°·0, and 0°·6. On one day a NW breeze (coming in, it will be remembered, at the front of the screen) brought the difference down to 0°·1.

At mid-day, that is, between 11 a.m. and 1 p.m., observations were taken on 6 days, on none of which was the Stevenson screen less than 0°·4 warmer than the zinc screen, the average being about 0°·7. These days were not selected out of many fine days, but were all the fine days on which observations could be taken between August 21st and September 20th.

On the contrary, the large wooden screen gave readings at mid-day agreeing very closely with the zinc screen. In cloudless and hot weather in June, towards the end of the afternoon, this wooden screen had become somewhat heated as compared with the metal screen. But in the cooler and more breezy weather of the period in question it was in close agreement with it, as it had been at 2 p.m. in the first series of observations.

On the whole, the results of experiment appear to agree with those which might be expected from theoretical considerations. The Stevenson screen certainly becomes unduly heated when the sun shines, but this may be as much due to its small size as to the material of which the louvres are made. The thermometers in it are only 3 to 5 inches from the louvres on the back

of the screen, against 7 to 8 inches in the zinc screen and as much in the large wooden screen. The roof too is single, and the box is open at the bottom. There is no need to condemn all wooden screens, but there does seem to be some reason to think that screens with metal louvres may be better. And the Stevenson screen is certainly open to objection.

The author is informed that in hot weather lower temperatures are not unfrequently registered on Glaisher stands than in Stevenson screens. Now it seems certain that the temperature shown by a thermometer on a Glaisher stand on a fine day in summer is too high. For a detailed discussion of this matter, the author would refer to his paper on "Temperature in Sun and Shade," * in which the thermometers described as "screened from sun and three-quarters of sky" were really on a sort of Glaisher stand. It is sufficient here to say that a thermometer so placed is exposed to a considerable amount of heat radiated from the ground, and also usually receives more heat reflected from clouds than it loses by its own radiation. These points were carefully worked out in that paper, and in particular it was found that the mere placing of a small board beneath one of two thermometers on the Glaisher stand distinctly lowered its reading below that of the other.

If, then, a thermometer on the Stevenson screen reads sometimes higher even than on the Glaisher stand, its error must in extreme weather be very considerable. The author has no particular prejudice for or against any form of screen or stand, but he has devoted much thought to the subject, and in past years has learned something from various failures.

The Stevenson screen is a useful one. Its principle of double louvres sloping in contrary directions is by far the best. No screen ought to be made on any other principle, whether of wood or metal. But its other arrangements are not so good. The single roof is insufficient to protect the screen against the sun when it has attained any considerable altitude. There is no protection against heat radiated or reflected from the ground except the narrowness of the box. It is so small that some at least of the thermometers must be very near the louvres, and they must always be inconveniently crowded. In calm weather the circulation of air through the box is very feeble. In consequence of some of these defects there can be no doubt that it is liable to become unduly heated, and while it may do for Scotland and the north of England, where there is much wind and little sun, it is not so well suited for England generally, and not at all for southern climates.

However, the screens which are used at many of the stations of this Society are not really Stevenson screens, but similar screens of a larger size, usually without the little chimney, but possessing ventilation just under the roof, and some of them having protection against heat coming from the ground. And those used by the Meteorological Office are similar in character. The increase of size is a very important improvement. A further increase

* *Quarterly Journal*, Vol. 1, p. 146.

in the size may be suggested, for convenience as well as accuracy, and the use of a double roof overhanging a considerable distance; also the outer louvres should be wider and further apart; and there should always be some protection from heat-rays from the ground. And it would probably be best to make the louvres of zinc. If these points were attended to, there seems no reason why a screen should not be produced which might be used in any part of the world. Obviously for southern climates great attention ought to be paid to the roof, and to protection from heat radiated or reflected from the ground. The author does not claim to have made a cosmopolitan screen: a southern sun would demand a much better roof. But he hopes he has contributed something to the discussion of a subject of interest and importance.

APPENDIX.

Detailed Description of the Zinc Screen.

A rectangular frame of wood is made 2 feet long, 18 inches wide, and 2 feet high, exclusive of the roof. The frame is closed at the top by thin boards, between which a narrow space is left, and over these are placed at an angle two 1-inch boards forming a ridge parallel to the front and back, the highest part of which is 8 inches above the top of the box. This outer roof overhangs 1 inch in front and behind, and 1½ inch at the sides, and might perhaps with advantage have been made both higher and to overhang more. Its ends are closed by perforated boards placed flush with the sides of the frame. The bottom is partly closed by an arrangement of boards contrived to admit the air while screening the bulbs of the thermometers from radiation from the ground.

The chief feature of this screen is the use of zinc louvres. These are made to slope two ways, as in the Stevenson screen, but each louvre is double, being bent down its length at a right angle into two unequal portions. The outer portion of the louvre is 2 inches wide and the inner ¾ inch. The clear space between each two louvres is ⅜ inch. Ordinary sheet zinc is used. The ends of the louvres are let into saw-cuts in slips of wood which are firmly screwed to the framework. It is sufficient to make saw-cuts for the outer portion of the louvres; they are then slipped in with their outer edges flush with the outside of the frame, and can be tightened if necessary with a little putty. The door opens like that of the Stevenson screen; but, from the construction, it can be let down, reversed, into a vertical position, and no chain is required. Ordinary brass hinges are used, and the door is fastened at the top by a button.

The thermometers are hung upon laths running down from the roof in the centre of the box.

DISCUSSION.

Mr. Mawley said he regretted that the author had had no opportunity since his new screen had been made of continuing the comparisons during severe weather, for after all it was only as to the accuracy of these exceptional extremes that observers generally entertained much doubt. The new screen contained two

great improvements—its larger size and thinner louvres, each of which conditions allowed a freer circulation of air within the screen. And it was quite as much to this freer circulation of air round the thermometers, and their greater distance from the south and west louvres, as to the metal louvres that the slight differences given in the paper were, he thought, to be attributed. For his own part he considered the Stevenson screen, notwithstanding its narrow limits and close louvres, to be a great step in advance of all previous thermometer screens, and for all practical purposes as satisfactory as could well be desired. On July 15th, 1881, it was very severely tested, and yet taking nine stations in and round London, the extreme difference between the maximum readings only amounted to 2½° (92°·4 to 95°·0), and at five of these stations varied only 0°·5 (93°·0 to 93°·5). And yet, small as these differences were, he had reason to believe that even closer approximations still would have been obtained had the thermometers in every case been similarly situated in respect to the south louvres and the screens themselves been at the time equally white. It was essential that Stevenson screens should be made alike in all respects, and with a view to uniformity in this matter, he thought it a pity the Society did not possess a standard screen of proper size and with suitable internal arrangements, and that meteorological instrument makers and others could not be induced to keep strictly to this standard pattern. Another point of practical importance was to have all these screens thoroughly well painted in the first instance, and then one coat of paint each year in the spring would be sufficient in most cases to keep them in a satisfactory condition throughout the summer. He had found white zinc paint mixed with clear copal varnish to give the most glossy and durable surface. One disadvantage of a zinc screen would be that no paint would for any length of time adhere to it. And, on the other hand, if it were not painted white he should have thought it would become more heated than wood; in proof of which he mentioned that he had used zinc "helmets" to protect rose-blooms during the exhibition season, but found they became so hot after long exposure to the sun that he could scarcely bear his hand upon them. The author had stated that he had been informed that in very hot weather a Stevenson screen often gave higher readings than even a Glaisher stand, but Mr. Mawley could not understand this, as he had taken observations on both these stands during the last five years, and in no instance when the temperature rose to or exceeded 80° had he found thermometers in the Stevenson screen give higher readings than on the Glaisher stand. He did not understand from the paper that the author advocated the substitution of metal-louvred screens for the wooden ones now so generally in use, but rather that he was desirous of showing how in his opinion the latter might in some measure be improved. This he was pleased to see, as he always considered it unadvisable to unsettle observers unless there was an urgent necessity for some radical change being made in their method of observation.

Dr. MARCET considered it very important that screens should be of a uniform description; the best would be constructed so as to thoroughly check radiation, allowing a perfectly free circulation of air round the thermometers. The influence of the direct sun's heat upon a screen should be avoided, especially in warm countries. For instance, solar radiation at 9,000 feet high on the Peak of Teneriffe being reckoned by Prof. Piazzi Smyth at 212° in summer, thermometers inside a screen, exposed to such a powerful sun, would undoubtedly become unduly heated. While residing at Cannes he had two thermometer screens not so closely louvred as the Stevenson screen; one of them containing maximum, minimum, and dry and wet bulb thermometers, was placed on a first-floor balcony on the N side of the house, where the sun never shone on it; and the other, containing a minimum thermometer, was placed on a lawn about 4 feet above the ground, on the S side of the house. He found that there was a slight difference between the readings of the minimum thermometers under the two screens, the observations on the lawn being lower by a mean of 1°·1; these were adopted as the most satisfactory.

Mr. DINES said his remarks would be confined to two stands, and which he had used side by side for some years; one was a Glaisher stand, the other a louvre stand nearly 3 feet square in front, and 2 feet 4 inches deep. Taking the minimum temperature, the average was always lowest upon the Glaisher stand, and, generally speaking, the maximum was the highest. The average of daily

On the effect of different kinds of Thermometer Screens, and of different exposures, in estimating the Diurnal Range of Temperature at the Royal Observatory, Cape of Good Hope. By David Gill, LL.D., F.R.A.S., Her Majesty's Astronomer at the Cape of Good Hope.

[Read June 21st, 1882.]

In the year 1841 an observatory, built of wood, and specially planned for magnetic and meteorological observations, was erected in the Observatory grounds. The thermometers in this observatory were placed in a well-ventilated screen before a south window, through which they could be read. The observations were made under the superintendence of Captain (afterwards General) Wilmot, R.E., at intervals of every two hours, from 1841, April 1 to September 30, and afterwards at every hour (Göttingen mean time) from 1841, October 1, to 1846, June 30. Observations on this scale were then brought to a close, and the magnetical and meteorological observatory was placed under the superintendence of the Astronomer Royal at the Cape, Mr. (afterwards Sir Thomas) Maclear; while the hours of observation were restricted to 1h., 5h., 9h., 17h., and 21h., Göttingen mean time. On 1852, March 12, the magnetic and meteorological buildings were burnt down.

A small wooden house, with double roof, and affording a free passage of air, was then erected on the site of the old meteorological observatory. The instruments were placed in the middle of this building, and observations were resumed on the same plan as before, and continued until the end of August 1858.

On 1858, September 1, the meteorological instruments were transferred to a screen erected in front of the south-west window of the transit circle room. In this position the thermometers were conveniently accessible for reading, and the general arrangement of the screen appears to have been somewhat similar to that of the old magnetic observatory. The screen is well ventilated, except on the side next the transit room window, but the great mass of solid masonry in the immediate neighbourhood of the thermometers appears seriously to affect the range of temperature.

There are thus three periods in the meteorological records of the Cape Observatory, and in the discussion of all secular or periodic variations of temperature it is essential to keep these periods in view.

Period I.	1841 April 1, to 1852 March 12	The Window Screen of Old Magnetic Observatory.
Period II.	1852 April 1, to 1858 August 31	The Ventilated House on Site of Magnetic Observatory.
Period III.	1858, September 1 to present date	The Screen attached to SW Window of Transit Circle Room.

In 1871 the author's predecessor, Mr. E. J. Stone, F.R.S. (now Radcliffe Observer at Oxford), discussed and published the results of meteorological

rations made between the years 1841 and 1870.* He derives from is data the most probable index errors of the thermometers from time to the mean temperature for each year, and tables for reducing observations at any hour of the day to the mean temperature of the day. These latter are derived from the hourly observations made from 1841 to 1846.

:he absence of an exact plan of the thermometer screen and its surround- in the old magnetic observatory, the author proposes to endeavour to ain how far the diurnal variations derived from the records of 1841-46 l with those of the present day, as shown by the present window screen, lso to compare the results of the window screen readings with those from ometers in other screens and exposures.

art from the interest which the matter has from a purely meteorological of view, it is of the greatest importance in connection with refraction he astronomical results of the observatory. The results given in the ing paper constitute a preliminary inquiry on the subject.

r many years a Glaisher stand, of the type employed at the Royal Obser- 7, Greenwich, has been in use. In the end of 1880 the author caused venson screen, of the type recommended by the British Meteorological (and adopted since 1880 by the South African Meteorological Commis- to be erected in the immediate neighbourhood of the Glaisher stand.

e hours of observation were 1h. 22m., 10h. and 18h. (6 a.m.), Cape time. The first of these corresponds with the international simul- us meteorological reading, and the other hours have been selected as nient for the ordinary routine of the observatory, whilst at the same :he mean of the three readings corresponds closely with the mean tem- ıre of the day.

:ording to Mr. Stone's Tables the following are the corrections in ques- —

TABLE I.

	1h. 22m.	10h.	18h.	Mean.		1h. 22m.	10h.	18h.	Mean.
	°	°	°	°		°	°	°	°
ary	−5·67	+2·80	+3·70	+0·3	July	−5·12	+1·32	+3·73	0·0
ıary	−6·15	+2·33	+4·39	+0·2	August ..	−4·47	+1·31	+3·40	+0·1
h ..	−6·42	+2·24	+4·78	+0·2	September	−4·99	+1·72	+3·89	+0·2
....	−6·18	+1·87	+4·49	+0·1	October ..	−5·66	+2·61	+3·90	+0·3
....	−4·97	+1·60	+3·43	0·0	November	−5·54	+2·70	+3·40	+0·2
....	−4·67	+1·12	+3·32	−0·1	December	−5·79	+3·00	+3·70	+0·3

ble II. gives the mean results of readings made in the three stands -mentioned, at the hours in question.

e thermometers employed were compared with each of the four obser-

esults of Meteorological Observations made at the Royal Observatory, Cape of Good Discussed and printed under the superintendence of Edward James Stone, F.R.S., 1871.

vatory standards at the end of 1880 and beginning of 1882. The index errors of the standards were determined in melting ice on both occasions. The results given in Table II. are corrected for the errors of the thermometers.

TABLE II.—Dry Bulb Thermometer.

1881.	1h. 22m.			10h.			18h.		
	Window Screen.	Stevenson Sceen.	Glaisher Stand.	Window Screen.	Stevenson Screen.	Glaisher Stand.	Window Screen.	Stevenson Screen.	Glaisher Stand.
	°	°	°	°	°	°	°	°	°
January	75·6	78·4	81·3	67·2	67·1	67·3	64·2	63·7	64·3
February	75·2	78·6	80·7	64·6	63·7	63·6	62·3	61·7	62·0
March	72·7	77·2	78·9	63·0	62·1	61·4	60·3	59·5	59·4
April	66·0	69·4	70·7	57 7	56·4	56·1	56·0	55·0	54·4
May	60·2	62·1	62·7	55·2	54·4	53·8	53·6	52·4	51·8
June	60·0	63·1	63·4	54·5	53·0	52·6	52·2	51·0	50·4
July	59·1	62·1	62·4	51·1	49·5	48·6	49·2	48·0	47·3
August	59·5	62·2	63·0	54·0	52·4	52·0	51·3	50·2	49·6
September....	65·2	67·3	68·4	57·1	56·0	55·3	55·6	54·5	54·2
October	70·9	74·1	75·9	57·9	57·5	56·9	58·7	58·1	58·1
November	68·5	71·7	73·7	57·9	56·8	56·2	59·7	60·1	60·5
December	72·6	77·0	79·2	61·7	61·1	60·7	63·9	64·6	65·2

The application of Mr. Stone's Tables to the above results may now be tested.

In the first place the mean temperature of the day is as follows:—

TABLE III.—Mean Temperature of the Day.

1881.	Window Screen.	Stevenson Screen.	Glaisher Stand.
	°	°	°
January	69·3	70·0	71·3
February	67·6	68·2	69·0
March	65·5	66·5	66·8
April	60·0	60·4	60·5
May	56·3	56·3	56·1
June	55·5	55·8	55·4
July	53·1	53·2	52·8
August	55·0	55·0	55·0
September	59·5	59·5	59·5
October	62·8	63·5	63·9
November	62·4	63·1	63·7
December	66·4	67·9	68·7
Mean	61·0	61·5	61·7

Taking the mean temperatures of the above Table III. as the observed mean temperatures, and reducing the temperatures of Table II. to mean temperature of the day with the data of Table I., the following comparison is obtained between the computed, and the observed, mean temperature:—

TABLE IV.—Excess of computed over observed (corrected) Mean Temperature for each of the three hours of observation, according to the readings on each Stand.

1881.	1h. 22m.			10h.			18h.		
	Window Screen.	Stevenson Screen.	Glaisher Stand.	Window Screen.	Stevenson Screen.	Glaisher Stand.	Window Screen.	Stevenson Screen.	Glaisher Stand.
	°	°	°	°	°	°	°	°	°
January	+0·6	+2·7	+4·3	+0·7	−0·1	−1·2	−1·4	−2·6	−3·3
February	+1·4	+4·2	+5·5	−0·7	−2·2	−3·1	−0·9	−2·1	−2·6
March	+0·8	+4·3	+5·7	−0·3	−2·2	−3·2	−0·4	−2·2	−2·6
April	−0·2	+2·8	+4·0	−0·4	−2·1	−2·5	+0·5	−0·9	−1·6
May	−1·1	+0·8	+1·7	+0·5	−0·3	−0·7	+0·7	−0·5	−0·9
June	−0·2	+3·6	+3·3	+0·1	−1·7	−1·7	0·0	−1·5	−1·7
July	+0·9	+3·8	+4·5	−0·7	−2·4	−2·9	−0·2	−1·5	−1·8
August	0·0	+2·7	+3·5	+0·3	−1·3	−1·7	−0·3	−1·4	−2·0
September ..	+0·7	+2·8	+3·9	−0·7	−1·8	−2·5	0·0	−1·1	−1·4
October	+2·4	+4·9	+6·3	−2·3	−4·4	−4·4	−0·2	−1·5	−1·9
November	+0·6	+3·1	+4·5	−1·8	−3·6	−4·8	+0·7	+0·4	+0·2
December	+0·4	+2·3	+4·7	−1·7	−3·8	−5·0	+1·2	+0·4	+0·2
Means ..	+0·5	+3·7	+4·3	−0·6	−2·2	−2·8	0·0	−1·2	−1·6

It is evident from a glance at Table IV. that the corrections deduced by Mr. Stone from the observations 1841-46 are not applicable to the thermometers exposed in the Stevenson Screen and the Glaisher Stand, though they approximate to those required for the present Window Screen. Thus the range between the observed mean temperature for the year, at the hours of 1h. 22m. and 10h., exceeds the computed range as follows:—

	Window Screen.	Stevenson Screen.	Glaisher Stand.
Excess of Observed Range	+1°·1	+5°·9	+7°·1

The obvious conclusion is that the exposure of the thermometers from 1841-46 was such as to give, in every case, a distinctly smaller daily range than in either of the three exposures now employed. It must, therefore, be considered whether the screen of 1841-46 could be held to have given a fair approximation to the true diurnal variation of temperature.

It is by no means impossible that the temperatures recorded on the Glaisher Stand in the strong sunshine of South Africa are in the day time above the true temperature of the air, on account of radiation, and perhaps also by convection from the heated soil. It is also possible (well ventilated though the Stevenson Screen is) that in strong sunshine some heat may penetrate by conduction to the inside of the screen, unduly raising the temperature of the thermometers by radiation from the sides of the screen, or the air as it passes between the louvred openings of the screen may be slightly heated. At night also it is not unlikely that the indications of the thermometers in the Glaisher Stand may be unduly lowered by radiation to the sky; but no such objections could be urged against the indications of the thermometers in the Stevenson Screen, where, in fact, the only argument against their truth might be that at 10 o'clock at night the sides of the Stevenson Screen may not have yet cooled down to the temperature of the air, and therefore the readings may be unduly high.

Practically, at least, it is impossible to conceive how the thermometers in the Stevenson Screen could read too low at night. Yet it will be seen from Table II. that the mean temperature of the Window Screen for the year 1881 at 10 p.m. is 58°·5, as compared with 57°·5 for the Stevenson Screen, and, therefore, that the temperature of the air at 10 p.m. is registered at least 1° too high by the Window Screen.

It also appears from Table IV. that the diurnal correction at 10 p.m., for the thermometers exposed as in the old magnetic observatory, is insufficient to correct the temperature at 10 p.m. to the mean daily temperature, by 0°·6, and therefore the temperatures at 10 p.m. were registered at least 1°·6 too high in the old magnetic observatory.

This result is, of course, more distinctly marked in the mean maximum and minimum readings, given in the following table V.

TABLE V.

1881.	Mean Minimum.			Mean Maximum.		
	Window Screen.	Stevenson Screen.	Glaisher Stand.	Window Screen.	Stevenson Screen.	Glaisher Stand.
	°	°	°	°	°	°
January	60·9	59·4	58·6	78·2	82·2	85·2
February	59·9	58·1	56·9	77·2	81·7	84·7
March	57·5	55·7	54·5	75·2	80·6	83·5
April	53·5	51·6	49·7	67·8	71·3	73·7
May	52·2	50·4	48·1	62·0	63·7	64·8
June	50·3	47·5	46·1	62·7	65·5	66·0
July	46·7	43·3	40·7	61·1	63·6	64·0
August	50·0	47·3	45·2	64·5	64·2	64·8
September	53·3	50·2	49·0	68·2	71·3	71·5
October	55·1	51·2	48·8	73·8	77·2	79·1
November	55·0	51·6	50·3	71·2	74·8	76·9
December	59·0	56·5	55·0	75·3	80·0	83·2
Mean	54·5	51·9	50·2	69·8	73·1	74·8

Whence results the following table of mean daily range of temperature.

TABLE VI.—Mean Daily Range of Temperature.

1881.	Window Screen.	Stevenson Screen.	Glaisher Stand.
	°	°	°
January	17·3	22·8	26·6
February	17·3	23·6	27·8
March	17·7	24·9	29·0
April	14·3	19·7	24·0
May	9·8	13·3	16·7
June	12·4	18·0	19·9
July	14·4	20·3	23·3
August	14·5	16·9	19·6
September	14·9	21·1	22·5
October	18·7	26·0	30·3
November	16·2	23·2	26·6
December	16·3	23·5	28·2
Mean	15·3	21·1	24·5

The following table, giving the absolute maximum and minimum readings in each screen in each month, brings out still more clearly the peculiarities of each stand.

TABLE VII.—ABSOLUTE MAXIMUM AND MINIMUM READINGS FOR EACH MONTH.

1881.	Minimum.			Maximum.		
	Window Screen.	Stevenson Screen.	Glaisher Stand.	Window Screen.	Stevenson Screen.	Glaisher Stand.
	°	°	°	°	°	°
January	54·5	50·3	47·9	88·8	94·9	98·8
February	50·9	45·1	42·8	91·4	99·8	103·2
March	49·3	45·1	43·3	91·6	96·7	98·6
April	45·1	41·1	38·4	82·0	88·6	90·0
May	43·8	39·7	37·5	67·2	71·5	72·0
June	40·3	34·5	32·9	75·0	80·9	80·4
July	38·8	33·5	32·6	[74·5]	78·7	78·0
August	44·0	39·7	36·8	78·8	81·8	82·0
September	43·5	38·6	36·4	85·8	89·3	90·6
October	48·8	43·1	40·8	95·3	98·7	99·7
November	49·0	43·5	41·6	88·6	95·4	97·9
December	54·7	50·1	48·3	86·3	94·0	97·0
Mean	46·9	42·0	39·9	83·8	89·2	90·7

These tables show conclusively how misleading may be the meteorological data of a particular station if there is no precise information as to the kind of thermometer screen employed, and as to whether the screen is fully exposed or in the immediate neighbourhood of, and shaded by, buildings.

The author defers any discussion of the absolute errors of the temperatures near maximum until further experiments have been made. He proposes to place the thermometers in a louvred box of thin copper, and this surrounded at a considerable distance by an efficient well-ventilated shade; the box containing the thermometers to be protected from radiation from the ground and from the surrounding shades by louvred copper screens.

DISCUSSION.

Mr. MAWLEY said that when he was staying at Cape Town, in 1876, he visited the observatory there, and he well remembered having some conversation with Mr. Stone, who was then Astronomer Royal, as to the best form of exposure for thermometers in such a climate, and recommending a Stevenson Screen. He believed that this was the first instance of one of these screens being tried in so hot a climate, and he was glad to hear that not only had his suggestion been at last adopted, but that in the comparisons instituted between the Glaisher Stand and Stevenson Screen, the latter had come out so well, giving results intermediate between those in the window screen and those on the Glaisher Stand. There being no grass out there, and the soil being very sandy, the thermometers on the latter necessarily became unduly heated during the hottest part of the day.

MECHANICAL CONDITIONS OF STORMS, HURRICANES, AND CYCLONES. By WILLIAM FORD STANLEY, F.M.S. (Abstract.)

[Read May 17, 1882.]

THE author commenced by pointing out that the influence of cyclones in determining atmospheric motion was now universally recognised. These vary in intensity within wide limits; inside the area of their influence the motion of the air is vorticose, *i.e.* it is an inward spiral movement; the barometer being lowest at the centre of the system.

This principle is always active, although sometimes masked by conditions of local resistance caused by elevation of land, cross currents, &c.

Dove has shown that cyclonic areas move at rates varying from 2 to 30 miles per hour, and over Western Europe the direction of motion is generally north-easterly. The author is not aware that any satisfactory explanation of this motion has yet been proposed.

Storms and cyclones passing over a definite locality have generally been observed under the following conditions as to barometrical pressure at the place of observation:—

1. Period of normal or somewhat lower pressure, often with the air quite still.

2. Advancing period of cyclonic action, the barometer falling continuously until the centre of the cyclone arrives at the place of observation.

3. Declining period of cyclonic action, the barometer gradually rising again to the normal, or to a point a little lower than it was before the approach of the cyclone.

By these conditions, as pointed out by Dove, the area of low pressure advances upon the area of higher pressure. As this matter is frequently misunderstood, it will be well to quote the words of Dove. "The following statements will be sufficient to explain in a few words my views on this much-vexed question. It is erroneous to suppose that in the case of extensive barometrical oscillations, the air always flows towards the point where the pressure is least; or, in other words, that the wind is always due to a disturbance of barometrical equilibrium. Such an interpretation would hold good neither for the cyclones, the direction of whose advance is at right angles to that of the prevalent wind, nor for the storms of the temperate zone, in which when the equatorial current is forcing its way onwards, the barometrical minimum is advancing in the direction of the current, and the air accordingly is flowing towards a district in which the barometrical level form of coast, or of mountains inland, is such as to be capable of producing a is relatively higher than in that from which it has travelled." *

There is yet a further condition open to consideration, which is, that the most violent storms occur where there is the most direct opposition from resistance by land to tropical currents flowing in a westerly direction, as in the westerly impulse of the Trade winds. Storms are most violent where the

* Dove's *Law of Storms*, p. 268. English Edition. Translated by R. H. Scott, M.A. 1862.

of coast, or of mountains inland, is such as to be capable of producing a erly or southerly deflection of the tropical current. This is the case the tropical Atlantic system, the atmospheric currents of which are ted towards the south and north from an axis about Cape St. Roque uth America, the northward deflection being still further increased by isposition of land in North America, which produces, at the seasons of est temperature changes (near the equinoxes), the hurricanes and storms e West Indian Isles. In the same manner also the westerly drift over ndian Ocean upon Eastern Africa brings about hurricanes eastward of frican coast. The similar resistance of Eastern Asia to the Northern c system produces in the same manner the typhoon storms.

e author then proceeds to explain vortex motion as being the only form tion as yet demonstrated experimentally by which one part of a fluid or an be projected within another part at rest, and gives an explanation of henomena which occur in the case of simple constant pressure, as, for ice, when two volumes of a gas at different pressures are separated by an ure (Fig. 1), a conical jet then issues towards the side of the lesser ure with very little projection.

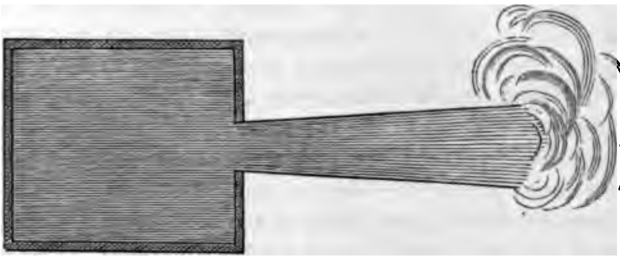


FIG. 1.

e author next describes Prof. Tait's mode of producing vortex rings by of a box of which the lid is of canvas and the bottom perforated with e (Fig. 2). This box is set on its side, and some ammonic-chloride r is introduced. As soon as the box is filled with vapour, a slight on the canvas will project a smoke ring from the hole to a distance of 40 feet.

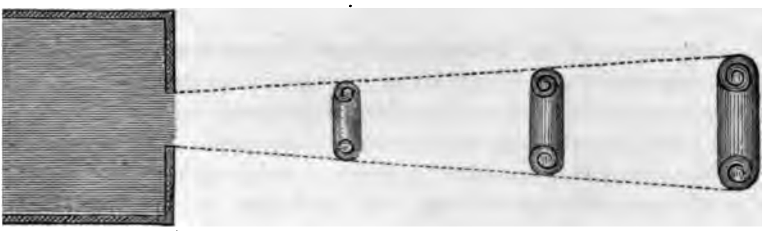


FIG. 2.

If the motions of the vortex ring be carefully observed, its matter is found to be in revolution by the axial or inner part in front of the ring being projected outwards; so that if one of these rings were projected from west to east, the northern horizontal section of the ring would resemble the observed direction of currents in the northern hemisphere. This outward flow, as shown in Fig. 3, is known in vortex systems to complete a spiral, by moving upon the inner parts by exactly the same kind of motion as that which takes place in an atmospheric cyclone. The vortex is shown in section in Fig. 3. This particular form of motion is engendered by impulses only, and is entirely different from the first form of motion considered, Fig. 1, or that derived from a constant pressure; the pressure being found to produce only a small direct projection, whereas the impulse produces a highly projectile form of motion. Further, the constant pressure causes only a direct motion of little translatory force, while the impulse produces a cyclonic or verticose motion. Hence, from the nature of storms projected through greater pressures in quiescent air, there follows the *primâ facie* evidence, that this could only occur with the vortex form of motion, even if this form had not been directly traced by observation in the storms themselves.

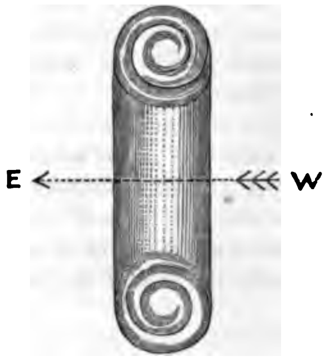


FIG. 3.

In the experiment with the box just given, it may be observed that the centre of the vortex is relatively free, and that the rotation bends over to the resistance first caused by the periphery of the hole. It is nevertheless clear that the friction of the air would alone produce this effect. This has been proved by the author in principle for various fluids by experiment.*

The author points out that solar heat is generally admitted to be the cause of aerial displacements. He describes the diurnal movement of the barometer as greatest between the tropics, and shows that the whole action of the sun's heat must be tractive in the direction of his own motion, that is, from *E* to W, traversing the globe in 24 hours.

This action is modified by the principle pointed out by Hadley (Phil. Trans., 1735) that in the northern hemisphere winds commencing as south winds become south-west, and winds commencing as north winds become north-east.

The vapour of the Trades ascends and is condensed. This condensation instantly produces a diminution of pressure in the upper regions, and tends to generate an impulsive action which is greatest in the upper regions, and is not easily measurable by the barometer at sea level.

The author then considers the action of high land in modifying the motion of the upper atmospheric strata, and holds that, *e.g.* the West India hurri-

* *Fluids*, pp. 265-271.

canes are generated by these obstacles, and that they are projected far into the Atlantic, sometimes even to Europe.

Experimental Conditions of Vortex Sections.—An experiment of Professor O. Reynolds,* shows that effects equivalent to those produced by Professor Tait's vortex apparatus in air, may be produced in water, the projected water being made visible by colouring matter, as the movement of the air is rendered visible by smoke. This experiment opens out a method of following vortex motions in water; and as these motions in water are slower than in air, they are more easily observed. Professor Reynolds projects the vortex or whirl-rings from the end of a deep trough 8 feet long filled with water; the projection is made by pressure upon a piece of thin sheet India-rubber stretched over the mouth of a funnel containing coloured water, the stem of the funnel being inserted in the trough deep in the water. The author has found that if the water be lowered to the mouth of the funnel†, its surface will cut off part of the whirl-ring, so that the part only which is below the surface will be projected. The motion within the vortex is by this means clearly shown. The section of this ring at the surface will represent two whirlpools, which constantly diverge and increase in diameter (Fig. 4). The water being coloured, the whirls will be seen to be revolving each towards its centre, in which there is a deep depression. Now, if pressure were represented by the depths of water in the trough, it would follow that although the whirl currents were inflowing, the pressure in the centre of the section of the vortex ring would be less than in other parts. It is also evident from his experiment that the inflowing currents engender pressures, not internal but external, by the constant deflection of the tangential force of the rotary system. The author's own experiments show that any section of a vortex may be projected by cutting off the other parts by resistance; as, for instance, a thin section of a vortex ring may be projected between two plates.‡ The above experimental condition shows that in the case of the atmosphere the resistance of the surface of the earth may leave the horizontal elements of a vortex system only active, the vertical element being cut off by the friction of the land or sea. Cyclones may, therefore, represent parts of a vortex system, or there may be a complete vortex system engendered in one plane only. Further, the diminished pressure in the centre of the vortex or cyclone is not necessarily a down-flowing or an upflowing system, but a result merely of tangential action, where gravitating matter tends to take a position of equilibrium. This may be partially shown

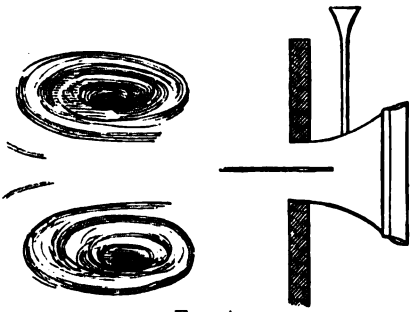


FIG. 4.

* *Proceedings of the Royal Institution.* Vol. viii. p. 272.

† *Fluids*, p. 220. ‡ *Fluids*, p. 221.

by a very simple experiment. If a cup of tea be stirred, so as to put the liquid in rotation, and then milk be poured in near the side of the cup, the milk will at first flow towards the centre in spiral lines without disturbing the general tangential action of the revolving liquid.

Assuming that the earth by resistance diverts the lower portion of a vortex system, there should be, according to the above conditions, at some distance above the surface of the earth, a cyclonic system revolving in two horizontal planes, the one from left to right, and the other from right to left. In Europe the rotation of cyclones is from right to left; it is, therefore, necessary to consider this case. Now, if it be assumed that the overflowing tropical current must return to the earth, as it cannot always be projected upwards from the same quantity of air, and that this current is pulsatory or projectile as is assumed and observed in winds, it may also be assumed that its return to the earth will be somewhere represented by an excess above normal pressure. This excess of pressure on the globe is found on the average principally about latitude 30°; but as the polar side of this downflowing current will be the colder, the condensation of vapour producing instantly a certain diminution of pressure, will have a constant tendency to draw the stream towards the cool side, so that the descending current is, on the average, probably spread over a latitude of from 30° to 40° at about the equinoxes. Therefore, if the vortices are projected as proposed in this paper, the northern part of this vortex, or cyclone, will be from right to left to the north of say 40°, but it will be from left to right between this and the equator; which the author presumes to be the case under normal circumstances, although he has no means of verifying it. Thus taking the Mediterranean to represent in this region the down-flowing area, the European vortex projections should, according to this theory, rotate their currents from right to left, and the African from left to right.

There is, however, another matter to be considered which will modify the above conditions, namely, that the relative velocities of the two sides of a bi-whirl or bi-cyclonic projection in a direction from west to east, will be materially affected by the difference of latitudinal arc in which the separate whirls are projected. This may be shown by a diagram (Fig. 5). Let W E

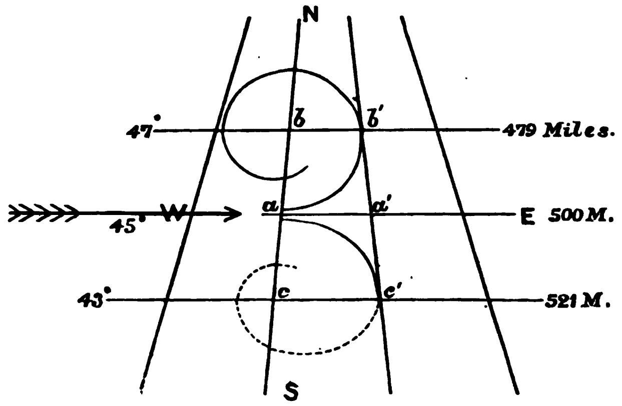


Fig. 5.

be the axial line of projection from west to east. Let the lines *a a′*, *b b′* represent parts of parallels of latitude. Then any body resting upon the earth, the air included, at *a a′* will have excess of motion over another body at *b b′*, in the ratio of the difference of lengths of latitudinal arcs *a a′* to *b b′*. Or any body resting at *c c′* will have like excess over *a a′*. Now take a certain latitude of the globe, say 45° N, where the surface of the earth will have an approximate velocity of rotation equal to 500 miles an hour, and suppose a westerly wind to be blowing with a velocity of 21 miles an hour (that is what Sir John Herschel describes as a good sailing breeze), this velocity must be evidently *plus* that of the earth's surface velocity, or 521 miles an hour. And suppose the wind to be deflected in a vortex system north and south, by any resistance, aerial or otherwise, near E, and that the deflections are such as would extend 2° to the north and to the south to form a vortex system or pair of cyclones of 240 nautical miles in diameter each. Now suppose the assumed northerly deflection of the wind to remove the air from its position at *a* to *b′*, it will then clearly be moved to a portion of the earth whose velocity is less, namely, about 479 miles an hour, whereas the wind maintaining its original force will be at 521 miles absolute velocity as before; it will, therefore, have a *plus* velocity over this part of the earth's surface to which it is deflected of 42 miles an hour, assuming it to maintain its force. Therefore, the cyclonic action continues in excess of the initial projection over the velocity of the earth at this position of 47°, and thereby may have power to complete the cyclone. And if it be supposed that the southern deflection be removed from *a* and the wind deflected 2° south to a position *c* by vortex motion, the wind, assumed as before to be of an absolute velocity of 521 miles an hour, will now be deflected to a position of the earth which possesses the same velocity as itself; therefore the air arriving in this position will have no *plus* velocity, and consequently become calm. From this it follows that westerly vortex currents will be unable to complete cyclones in temperate regions in this hemisphere if projected in a direction from left to right, so that cyclones from right to left only are observed. On a similar hypothesis it might easily be shown that easterly winds would be affected in like manner, but the author assumes that the above demonstration of the principle argued is sufficient.

DISCUSSION.

Professor ARCHIBALD remarked that he had just begun to read a book lately published by Mr. Stanley on "Fluids," in which a theory of cyclones was put forward, which he supposed was somewhat similar to that propounded in the present paper. The author evidently attached much importance to the formation of vortex-rings, such as the smoke-rings exhibited on the present occasion. He thought, however, that it had yet to be proved that the cyclones in nature were identical in all respects with the vortex-rings of the laboratory. For his own part, he considered the existing theories of cyclones, especially that of Ferrel, sufficient to account for all the phenomena observed.

Mr. RUNDELL said he was glad to have the opportunity of making some objections to the commonly received ideas of the mechanical conditions which influence cyclonic areas of low barometric pressure. He must beg the indulgence of the Fellows for so directly opposing what he believed to be the opinions of

several of the leading meteorologists. There appeared to him to be too ready an adoption of the views of Meldrum, without consideration of the very great mechanical difficulties which attended them. He had observed with regret the leaning which some of the Fellows were showing towards the idea that vast currents of air travelled by spiral lines towards a common centre during circular storms. His own view was that the preponderating force was a centrifugal one. He might illustrate it by what might be seen in country fairs, or in a crowded place when a mountebank wanted to clear a space for his performance. He began by taking up a boy by the middle and making him kick outwards very violently. By carrying round the boy in a constantly enlarging spiral course, he cleared away the crowd, and produced what he might term the area of low pressure in the middle. Of course, this was a rough illustration only. He admitted that analogy was not argument; and he trusted the author of the paper would excuse him for applying this remark to the very interesting experiment he had brought forward. It was difficult to treat in a popular way a matter which was so essentially mathematical. He had sometimes tried to consider the effect of friction or retardation on a stream of atmosphere, say a stream of ½ mile or so in width, forming part of those immense SW currents of perhaps 300 or 400 miles in width and 1,000 or 1,500 miles or more in length, which were sometimes depicted upon the daily weather charts. A retardation in any part of such a stream of air, even of very small extent, would cause what was termed a telescopic action when a railway-train was arrested in its motion, and there was an over-riding of the carriages upon one another. So the air would accumulate at the place of retardation, and produce an increase of barometric pressure far beyond experience, unless the retardation was exceedingly small. If this was the case when the stream was an isolated one, how much greater would be the result when a vast number of streams were all converging on one point, and when, instead of a small retardation, there was a total stoppage producing a central calm. The difficulty of conceiving the mechanical conditions necessary to the explanation of such a state of things seemed to him so great, that he feared to give a name to the theory that made such an explanation necessary. A German meteorologist had said that a current of tropical air coming from a low into a higher latitude, and meeting a relatively quiescent atmosphere, would necessarily produce a circular stream or area of equal pressure; and it was easy, he thought, to conceive a large circular ball of air impinging against an immense tube of quiescent air like a cushion to a gigantic billiard-table, and being constantly deflected by successive portions of comparatively still air, so as to produce a circular but centrifugal stream; and it must be remembered that circular streams of air presented much easier conditions of retardation or continuance of motion, as in fact was proved by the smoke-rings just exhibited, than was possible with vast streams of air moving in a straight line, or incurving towards a single point. He hoped he had said enough to show that Mr. Meldrum's idea should not be received except with caution and after ample consideration.

Mr. STANLEY in reply said that the vortex was the only form of motion known of free projection of one part of a fluid within another part. He conceived that physical laws of matter upon which any theory must be founded could be best taken from what had been termed laboratory experiments. He had worked out this paper independently of his book on "Fluids," in which only a few references had been made to the subject.

The PRESIDENT (Mr. Laughton) said that many of the statements and suggestions in the paper could scarcely be accepted without very distinct proof. Doubts as to the correctness of the geographical facts had already been referred to; and the question would naturally arise as to the way in which the vortex-rings were produced on a large scale over the surface of the earth. Another difficulty had occurred to him, which was this: The author had spoken of the rings as passing along unbroken, but with a half or, perhaps, a third of their circumference cut off by the ground; he could scarcely believe this possible: he believed that if the experimental rings struck the floor they would at once break up. Professor Archibald had referred at some length to Mr. Ferrel's investigations; for himself, he doubted the practical value of these: some of Mr. Ferrel's results were certainly very wide of the facts as observed; he thought that the data of the problem were too vague and too complex to admit of satisfactory mathematical treatment. Nothing, perhaps, would seem better established,

theoretically, than the tendency of a moving body, in the northern hemisphere, to diverge to the right; but he had never been able to find that this theoretical divergence had any where been observed. Several alleged instances he had himself been able to disprove: amongst others, the statement that in railways the right-hand rail was subject to excessive wear; or that gunshot had a deflection to the right: he had found no evidence in support of these statements, but a great deal of evidence, of the very best quality, in controvertion of them. He had thus been forced to the conclusion that the divergent effect of the rotation of the earth was practically swallowed up by the continuous friction.

PROCEEDINGS AT THE MEETINGS OF THE SOCIETY.

May 17th, 1882.

Ordinary Meeting.

John Knox Laughton, M.A., F.R.G.S., F.R.A.S., President, in the Chair.

Miss Wilhelmina L. Hall, The Gore, Eastbourne;
Edwin James Pearson, Millfield, Berkhampstead;
John R. Somerfield, M.D., Chesterfield; and
William John Vernon Vandenbergh, 77 Campsbourne Road, Hornsey,
were balloted for and duly elected Fellows of the Society.

The following Papers were read:—

"On the diurnal variation of Wind and Weather in relation to Isobaric Lines." By the Hon. Ralph Abercromby, F.M.S. (p. 213.)

"Mechanical Conditions of Storms, Hurricanes, and Cyclones." By W. F. Stanley, F.M.S., F.R.M.S. (p. 244.)

"Weather Statistics of Sydney, 1841-1846, and of Melbourne, 1848-1866," from the Diary of Andrew Ross. (p. 252.)

June 21st, 1882.

Ordinary Meeting.

John Knox Laughton, M.A., F.R.G.S., F.R.A.S., President, in the Chair.

The following Papers were read:—

"A new Metal Screen for Thermometers." By the Rev. Fenwick W. Stow, M.A., F.M.S. (p. 228.)

"On the Effect of Different Kinds of Thermometer Screens and of Different Exposures in estimating the Diurnal Range of Temperature at the Royal Observatory, Cape of Good Hope." By David Gill, LL.D., F.R.A.S. (p. 238.)

"Some Account of a Cyclone encountered from January 14th to the 19th, 1880, in the Mozambique Channel, by R.M.S. 'Danube,' Captain Draper." By Charles S. Hudson. (Abstract.) (p. 252)

"WEATHER STATISTICS OF SYDNEY, 1841 1846, AND OF MELBOURNE, 1848-1866," from the Diary of ANDREW ROSS.

Under the term "Fine" is included all those days that were fair or nearly so; and "Bad," all days which were more or less wet (except slightly).

Year.	No. of Days of					Weather Memoranda.
	Fine.	Bad.	Frost.	Hot Winds.	Thunderstorms.	N.B.—Months not stated are to be held as average.
1841	302	63	..	8	6	Jan. dry, except May, others rather dry.
1842	305	60	3	16	11	Feb. rather wet. Nov. dry, with hot winds, slight frosts at Hunter River.
1843	299	66	4	7	3	Aug. wet, Jan. Oct. and Nov. very dry, frost at Hunter River.
1844	298	68	..	1	4	March and Dec. very dry. June and Oct. rather wet.
1845	308	57	..	2	9	April and May wet, others rather dry.
1846	296	69	..	10	11	Aug. to Nov. rather wet, others rather dry.
1848	294	72	..	5	4	Feb. dry. May, Aug. and Nov. rather wet.
1849	286	79	6	4	..	Jan. and Oct. dry. April, July and Sept. rather wet. Storm Nov.
1850	311	54	..	14	5	Hot generally, rain in June, dry others.
1851	292	73	9	10	6	June, Sept. and Nov. wet, others dry.
1852	283	83	2	7	5	May, July, Aug. and Sept. very wet.
1853	290	75	12	11	6	May and Aug. wet, others rather dry.
1854	280	85	9	14	10	Jan. and Feb dry. Aug. wet.
1855	282	83	5	12	7	First 5 months very dry. Sept. very wet.
1856	284	82	6	9	7	May, June and July rather wet.
1857	284	81	15	8	8	First 5 months rather dry. Aug. Sept. and Oct. rather wet.
1858	293	72	8	15	5	July, Aug. and Sept. wet. Jan. and March very dry.
1859	280	85	8	12	8	Jan. July and Sept. rather wet. Dec. dry.
1860	286	80	5	11	11	General average throughout.
1861	266	99	12	22	14	July, Aug. and Oct. wet.
1862	287	78	8	15	13	Jan. Feb. and March dry. May, July and Dec. wet.
1863	265	100	10	8	9	May, Aug. Sept. and Oct. wet.
1864	286	80	4	30	6	April, Aug. and Oct; Jan. Feb. and March dry.
1865	305	60	11	21	12	First 4 months very dry, also the last 3 months.
1866	279	86	16	11	2	June, July and Sept. rather wet. Feb and March dry.

From 1851 to 1866 the record was kept at Kangaroo Ground, Melbourne. 1855—January 27th, the thermometer in the shade registered 102°; 1857—December 24th, 104°; 1863—February 2nd, 103°; and 1867—January 12th and 13th, 105°. 1849—November 26th to 27th: A violent storm, wind and rain in Hobson's Bay. 1851—February 6th: Great dust storm and violent hot wind. 1855—November and December: Storms, heavy rains. 1863—March 18th: Heavy rain. 1863—July: Very stormy. 1863—December: Great floods. 1866—June 11th: Severe frost.

"SOME ACCOUNT OF A CYCLONE ENCOUNTERED FROM JANUARY 14TH TO THE 19TH, 1880, IN THE MOZAMBIQUE CHANNEL, BY R.M.S. 'DANUBE,' CAPTAIN DRAPER." By CHARLES S. HUDSON. (ABSTRACT.)

This paper gives in detail the experience of the author, an officer on board the 'Danube.' A chart shows the track of the storm and also of the vessel.

The following are a few of the most important points in connection with the storm:—

On January 14th the 'Danube' was lying in Mozambique Harbour, and was apparently on the outer edge of a cyclonic storm passing to the westward, the centre of which was at this time somewhere to the southward. The vessel was bound to Delagoa Bay and Natal, and on her voyage apparently came within the influence of a cyclonic storm; at 5 a.m. on the 15th it was blowing a hurricane from about NNW. The author assumes that this cyclone had been traversing the Indian Ocean somewhat to the northward of the usual track, so far in fact that instead of recurving off the eastern coast of

Madagascar, to the south-eastward by the Mauritius, it had passed north of Madagascar and into the Mozambique Channel, and he considers its general course to have been at this time somewhere from west round to south-east. The chart shows the storm at this time to be travelling south-westward at the rate of about 5 or 6 miles per hour. The veering of the wind is taken to show that the vessel was under the influence of the cyclone on the 16th and 17th; and at noon on the 18th she was in the south-west quadrant of the storm, and the storm-centre is said to be travelling on a course to the eastward of south, having for a second time crossed the track of the vessel.

It is assumed that the cyclone, having entered the Mozambique Channel to the northward of Madagascar, did not meet with any obstruction from land until it impinged upon the African shore, south of Sofala; and had there been high land there, probably it would have recurved back to the SE at an angle of much greater acuteness than appears in the track laid down for it, but meeting on the coast with only low-lying land, it is assumed that the low-lying land had not the power to deflect it, and until it began to feel the influence of the high lands lying further in shore, that it continued on its original path.

The barometer was not at any time observed at a very low reading; each time the ship approached the storm-centre it appears to have given full warning, and always rose upon the storm-centre receding.

The direction of the track of the storm is the same as that of most Indian Ocean cyclones, only the point of recurvature is more to the westward, and it is assumed that this is where all thé Mozambique Channel cyclones find their origin, and that they may be all expected to travel on approximately the same path.

Cyclonic storms are rare at Mozambique; considering the number experienced at the Mauritius and in its north-eastern neighbourhood, it goes far to lay some value on the suggestion that a cyclone is only experienced in the Mozambique Channel when a cyclone generated over the Indian Ocean has travelled across to the westward, much to the northward of its average course, and recurves in the Mozambique Channel to the west, instead of east, of Madagascar.

"RAINFALL OF FRERE TOWN, MOMBASSA." 1875-1881. By R. H. TWIGG, M.Inst.C.E., F.M.S.

The following Table is compiled from daily observations of rainfall, taken by Mr. J. R. Streeter, agent of the Church Missionary Society. Mr. Streeter remarks that "The SW monsoon is ushered in with much thunder and lightning. Strong winds begin at the end of March, when all main crops are sown; and the NE monsoon commences in September, when we chance sowing some kinds of grain, but do not always reap as the crops get burnt up. Strange to say, the year 1880, although the total rainfall was light, was the best for crops, because the rains came at seasonable times, and some rain fell early in 1881."

Mr. Streeter also says, "The rain falls mostly at new moon in the dark early morn." The author's experience in the West Indies led to the conclusion that the moon's position had much influence on the force of the wind.

Another passage in Mr. Streeter's letter is to the effect that "There is little dew along the coast, but some 10 miles inland there is a range of hills almost 800 feet high, and on the other side there are heavy dews and rather more rain, so that rice grows up hill and down dale of superior quality and quantity to that grown in the swampy ground along the coast." The author may call attention here to his paper read before the Society in 1869 as to observations at Sombrero, West Indies. In that it is said there was no dew, but this was easily accounted for by the island being a bare rock.

It would appear from these rainfall tables that while Frere Town may be a healthy settlement, and well placed for communication with the external world, it is, owing to the want of dew and uncertainty as to the times of rainfall, a locality in which agriculture cannot be carried on profitably, while about 10 miles off the climate is all that can be desired.

The destructive falls of rain at Frere Town are instanced by a fall of 10·90 inches occurring in 36 hours on the 29th and 30th of April and 1st of May, 1878.

Rainfall of Frere Town, Mombassa, East Coast of Africa, Lat. 4° S, as measured by Mr. J. R. Street gauge 30 feet above the sea level, and 200 yards from the shore, 1 foot above ground; also parison the average fall for 5 years, 1874-1878, at Zanzibar, as measured by Dr. Robb.*

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
1875	..	..	5·00	7·09	14·12	6·28	9·21	1·88	·37	4·59	·35	4·68
6	·35	·18	3·57	6·00	16·16	3·11	4·60	2·68	2·66	·97	·56	·60
7	·25	·00	3·71	4·50	12·82	6·71	4·10	9·79	10·75	12·44	21·05	3·49
8	7·66	·51	4·75	12·46	4·46	8·08	1·90	4·26	3·09	3·04	2·09	·30
9	·37	3·17	1·39	10·50	16·36	4·31	2·02	1·81	1·25	4·04	3·20	·55
1880	·00	·36	1·96	6·31	9·62	1·10	9·45	1·39	·15	4·39	6·56	1·76
1	·78	5·60	..	..	..	..	..	..	..	..	..	..
Average Frere Town	1·57	1·64	3·40	7·81	12·26	4·93	5·21	3·63	3·04	4·91	5·64	1·90
Average Zanzibar	2·33	3·00	5·92	14·84	6·96	2·09	2·32	2·49	1·86	3·75	7·39	8·06
Quantity derived from falls of over 1 inch in 24 hours (extraordinary falls).												
1875	..	..	..	..	9·09	1·10	3·70	..	..	4·00	..	4·60
6	..	..	2·30	3·68	13·79	1·18	1·32	1·04	1·00	..	..	..
7	..	..	3·05	2·00	11·87	2·70	2·45	6·20	8·37	10·58	13·14	..
8	7·11	..	1·59	10·05	3·70	5·73	1·90	..	..	2·30	..	..
9	..	2·95	..	7·23	9·55	..	..	1·20	..	..	1·25	..
1880	..	..	..	4·03	5·08	..	3·12	..	..	2·10	4·67	..
1	..	..	..	..	..	..	..	..	..	..	..	..

The general characteristic of this rainfall, as shown by the above, is uncertainty, falls of over forming more than half the total; by eliminating these heavy falls, the remainder, when plotted, smooth curve, rising from 0·38 inch at the commencement of the year to a maximum of 3·41 in May, declining to 1·48 inch in September, rising to 2·46 inches in November, and then de again.

Mr. TWIGG said that his object in bringing the paper before the Society was to afford some reliable information as to the rainfall of a part of the world about which but little was known. He had compared Mr. Streeter's observations with those made by Dr. Robb at Zanzibar, and found them to agree very fairly.

Mr. STRACHAN remarked that as the rain-gauge was rather near the sea, spray might at times have been blown into it.

Mr. DYMOND objected to the author eliminating the large rainfalls in order to obtain a smooth curve. These heavy falls constituted a large portion of the annual rainfall, and so could hardly be styled "extraordinary" falls, and the curve obtained after their removal was not a representation of facts.

Mr. SYMONS believed that the author's idea was merely to separate the regular from the irregular rainfall, and so to show in a curve the rain which might be regarded as the absolute minimum and as sure to fall. Meteorological observations were much needed in Africa, and any information as to the meteorology of East Africa was especially useful, as so little was known about those regions. A good map of Africa coloured to show the proportion of rainfall had been constructed by the late Mr. Keith Johnston from travellers' notes of rainfall. He thought it was a great pity that English missionaries took so few meteorological observations. French, and especially German, missionaries frequently furnished records, which were not merely of scientific value but which tended to the advance of civilization.

Mr. STRACHAN remarked that he had inquired respecting the meteorological instruction given to missionaries, and had found that as a rule they received none whatever.

Mr. C. HARDING said that the method of charting meteorological observa-

* *Quarterly Journal*, Vol. VI. p. 30.

tions from travellers' notes was apparently the same as that extensively used by the late Captain Maury in dealing with observations at sea, and indeed was the method generally followed in the discussion of marine meteorology.

Mr. ELLIS remarked that the difficulty which the author had found in forming an average rainfall was felt in dealing with other elements, magnetical as well as meteorological. What should be retained or what discarded in forming means was sometimes a question. Thus at Greenwich the great magnetic storms were omitted in forming magnetic diurnal inequalities, whilst in regard to atmospheric electricity it was found better to retain all indications.

RECENT PUBLICATIONS.

ANNUAIRE DE LA SOCIÉTÉ MÉTÉOROLOGIQUE DE FRANCE. 30me Année, 1882. Janvier et Février. 4to.

Contains :—Sur les Expéditions polaires internationales, par L. Teisserenc de Bort (4 pp.).—Comparaison des observations faites à Marly-le-Roi, par M. Raymond, avec celles correspondantes du Parc de Saint-Maur, par E. Renou (2 pp.). —Les froids de janvier 1881 sur les Iles Britanniques, par M. W. Marriott ; et les tempêtes de neige du 17 au 21 janvier 1881, par M. H. S. Wallis, Résumé par T. Moureaux (8 pp.).—Le régime des pluies en France, par T. Moureaux (6 pp.).—Sur les mouvements du sol, par A. d'Abbadie (11 pp.).

CIEL ET TERRE. Revue populaire d'Astronomie et de Météorologie. Troisiéme Année. Nos. 11-16. August-October, 1882. 8vo.

Contains :—Le fœhn à Bludenz et la théorie du fœhn en général (5 pp.).—Les dépressions et les précipitations atmosphériques (8 pp.).—Utilité des observations météorologiques pour l'agriculture, par Von Hausen (4 pp.).—L'été de 1882 en Belgique, par J. Vincent (7 pp.).

CONTRIBUTIONS TO OUR KNOWLEDGE OF THE METEOROLOGY OF THE ARCTIC REGIONS. Published by the Authority of the Meteorological Council. Part III. Official, No. 34. 4to. 158 pp. 1882.

The meteorological observations discussed by Mr. R. Strachan in this Part were made at Winter Harbour, Winter Island, Igloolik, Port Bowen, Port Leopold, Wolstenholm Sound, Fort Simpson, Walker Bay, Cambridge Bay and Camden Bay.

JOURNAL OF THE SCOTTISH METEOROLOGICAL SOCIETY. New Series. Nos. LXIV.-LXIX. 8vo. 1882.

Contains :—The mean atmospheric pressure of the British Islands, by A. Buchan (18 pp. and 4 plates). This paper shows by the aid of maps the geographical distribution of mean atmospheric pressure for the months and the year during the period 1857-1880. A table is also given showing the mean monthly and annual pressure at 20 places in Ireland, 147 in Scotland, and 128 in England.—The mean temperature of the British Islands, by A. Buchan (19 pp. and 4 plates). This is a companion paper to the preceding one, and is treated in the same way.—The Meteorology of Rothesay, by A. Buchan (7 pp.).—Remarks on the climate, in relation to disease and mortality, of the Faroe Isles, by Dr. E. Madsen (9 pp.).—Directions for the measurement of trees, by the late Sir R. Christison (2 pp.).

MADEIRA METEOROLOGIC. By C. PIAZZI SMYTH, F.R.S.E., and Astronomer Royal for Scotland. 1882. 83 pp. and 2 plates. 8vo.

This is a Paper read before the Royal Society, Edinburgh, on May 1st, 1882, which the author has published in book form. The work is divided into five parts, viz. 1. Introduction to the chief feature of Madeiran Meteorology now to be inquired into ; 2. Cycle of a day, and succession of days, in Madeira as compared with Lisbon ; 3. Cycle of a year, in Madeira, as compared with several other places in nearly similar latitudes ; 4. Occasional phenomena peculiar to Madeira ;

and 5. General results for vegetable and animal life in Madeira. The appendices contain the results of observations made in Madeira and at other places.

METEOROLOGICAL CHARTS FOR THE OCEAN DISTRICT ADJACENT TO THE CAPE OF GOOD HOPE. Official No. 43. 1882.

REMARKS EXPLANATORY OF THE CHARTS OF METEOROLOGICAL DATA FOR THE OCEAN DISTRICT ADJACENT TO THE CAPE OF GOOD HOPE. Official, No. 43. 4to. 84 pp. 1882.

The series of charts consist of 24 large monthly charts, in 12 pairs; those to the left refer to wind, air temperature and pressure, and those to the right to ocean currents and sea surface temperature.

REPORT ON THE GALES EXPERIENCED IN THE OCEAN DISTRICT ADJACENT TO THE CAPE OF GOOD HOPE. (Between lat. 30° and 50° S, and long. 10° and 40° E.) By Capt. H. TOYNBEE, F.R.A.S. Presented to the Meteorological Council, and published by their authority. Official, No. 44. 4to. 111 pp. and 20 plates. 1882.

Capt. Toynbee has discussed in detail the gales of the months of January and July only, as these are considered sufficiently typical of the summer and winter seasons.

METEOROLOGICAL OBSERVATIONS AT STATIONS OF THE SECOND ORDER FOR THE YEAR 1879. Published by Direction of the Meteorological Council. Official, No. 45. 4to. 191 pp. 1882.

This contains the observations *in extenso* at 9 a.m. and 9 p.m. from 26 stations in the British Isles, and also the monthly and annual summaries from 36 stations.

METEOROLOGISCHE BEOBACHTUNGEN IN DEUTSCHLAND von 18 Stationen II. Ordnung, sowie von 8 Normal-Beobachtungsstationen und den Signalstellen der Deutschen Seewarte für 1880. Jahrgang II. 4to. 304 pp. 1882.

This contains the daily observations as well as the monthly and annual results from 18 second order stations in Germany; and also the hourly values for atmospheric pressure, temperature, and direction and velocity of the wind, from the following 7 stations, viz.:—Hamburg, Kiel, Wüstrow, Swinemünde, Neufahrwasser, Memel, and Keitum.

PROCEEDINGS OF THE ROYAL INSTITUTION OF GREAT BRITAIN. Vol. IX. Part 5. No. 74. 1882. 8vo.

Contains:—The Weather and Health of London, by A. Buchan (15 pp.).—Magnetic Disturbance, Auroræ and Earth Currents, by Prof. W. G. Adams, F.R.S. (16 pp. and 3 plates).

PROCEEDINGS OF THE ROYAL SOCIETY. Vol. XXXIV. No. 221. 1882. 8vo.

Contains:—On a Deep Sea Electrical Thermometer, by C. W. Siemens, D.C.L., F.R.S. (6 pp.) This contains the results of experiments made with the Electrical Thermometer and also the Miller-Casella Thermometer, by Commander Bartlett, of the U.S. Coast and Geodetic Survey, in August 1881.

REPORT AND TRANSACTIONS OF THE PENZANCE NATURAL HISTORY AND ANTIQUARIAN SOCIETY. 1881-82. 8vo.

Contains:—Meteorological Tables showing the mean temperature and rainfall for each month for 18 years, from 1860 to 1877, at Penzance, from observations made by Mr. W. H. Richards, and reduced by Mr. N. Whitley (3 pp.).

REPORT ON THE STORM OF OCTOBER 13-14, 1881. By ROBERT H. SCOTT, F.R.S. Published under the Authority of the Meteorological Council. Official, No. 46. 1882. 8vo. 23 pp. and 9 plates.

The author in this report deals with the area of the Telegraphic Reporting System and with such data only as have reached the Meteorological Office, in

order to show the degree of minuteness with which the telegraphic and other reports enable him to trace the history of such a storm and the degree of completeness of the warnings the authorities of the Office were able to issue of its approach. In an appendix, the author gives some particulars of the great storm of January 6th, 1839, whose course appears to have passed along a similar track to that of October 14th, 1881.

SYMONS'S MONTHLY METEOROLOGICAL MAGAZINE. Vol. XVII. Nos. 199-201. August-October, 1882. 8vo.

Contains :—The Copenhagen Meeting of the International Meteorological Committee (3 pp.).– The British Association at Southampton (3 pp).—Fifteenth Report of the Committee appointed for the purpose of investigating the rate of increase of underground Temperature downwards, in various localities of dry land and under water, embodying a summary of the previous fourteen reports (8 pp.).—Report of the Committee on the calibration of mercurial thermometers (6 pp.).—On the origin of Hail, by Prof. T. Schwedoff (2 pp.).

TRANSACTIONS OF THE HERTFORDSHIRE NATURAL HISTORY SOCIETY AND FIELD CLUB. Vol. II. Part I. August 1882. 8vo.

Contains :—On methods of prevention of Insect Injury, by Miss E. A. Ormerod (8 pp.).—The gale of the 14th of October, 1881, and its effects in Hertfordshire, by the Rev. C. W. Harvey (8 pp.).—The migration of birds, by J. E. Littleboy (15 pp.).

UNITED STATES OF AMERICA, WAR DEPARTMENT. PROFESSIONAL PAPERS OF THE SIGNAL SERVICE. Nos. 1, 2, 3, 5, 6, and 7. 1881-82. 4to.

General Hazen has commenced these "Professional Papers" with the view of bringing memoirs on certain subjects before the attention of the scientific world. No. 1. Report on the Solar Eclipse of July 1878, by Prof. Cleveland Abbe (186 pp. with 32 plates).—No. 2. Isothermal Lines of the United States, 1871-1880, by Lieut. A. W. Greely (4 pp. and 12 plates).—No. 3. Chronological list of Auroras observed from 1870 to 1879, compiled by Lieut. A. W. Greely (76 pp.).—No. 5. Information relative to the construction and maintenance of Time-Balls (31 pp.). —No. 6. The Reduction of Air-Pressure to sea level at elevated stations west of the Mississippi River, by H. A. Hazen (42 pp. and 20 plates).—Report on Six Hundred Tornadoes, by Sergeant J. P. Finley (19 pp. and 3 plates).

ZEITSCHRIFT DER ÖSTERREICHISCHEN GESELLSCHAFT FÜR METEOROLOGIE. Redigirt von Dr. J. HANN. XVII. Band. August-October Hefte, 1882. 8vo.

Contains :—Geschwindigkeit, Tiefe und Aenderungen der barometrischen Minima in den Jahren 1876 bis 1880, von Dr. J. van Bebber (11 pp.)—Die Entstehung der Cyklonen, von Dr. P. Andries (21 pp.)—Eine locale Gewitter-cyklone, von Dr. Assmann (5 pp.).—Die Höhe des Nordlichtes, von S. Tromholt (10 pp.).—Die Luftstromüngen über Berlin, dargestellt nach den Ergebnissen dreijähriger in fortlaufender Reihe fortgesetzter Wolken- und Windmessungen, von Dr. F. Vettin (7 pp.).—Untersuchung über die räumliche Vertheilung gleichzeitiger Neiderschläge in der Schweiz, von G. Mantel (8 pp.).

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THE END.

METEOROLOGY OF ENGLAND,

DURING THE QUARTER ENDING MARCH 31, 1882.

Remarks on the Weather during the Quarter ending March 31st, 1882.

By James Glaisher, Esq., F.R.S., *&c.*

The weather in January was remarkable for very high readings of the barometer and high mean atmospheric pressure for the month; total absence of snow, the very few nights on which the temperature on grass was below 32°, and consequently very few and slight frosts, and almost total absence of north and north-east winds. It was a mild pleasant month, being very warm during the first fortnight, and the last 5 days, with a rainfall below the average; at the end of the month all agriculture was a month in advance, and many flowers were in blossom in addition to the usual January flowers.

The weather in February was mild and pleasant, with a high barometer continuing till near the end of the month, and a high temperature from the 11th day, vegetation was very forward at the end of the month.

The weather in March was singularly mild and pleasant, being exceptionally warm during the first 20 days, and quite genial; on the 21st and 22nd, a little snow was general over the country, and the temperature on the 21st, 22nd, and 23rd was slightly below the average, but it became warm again on the 24th. The weather from November to this time was most favourable for farming work, and at the end of the quarter vegetation was very forward.

About London the mean daily temperature of the air was above its average till the 16th day, and the mean daily excess of these 16 days was 6°·6; it was generally below its average from the 17th to the 26th; the average daily deficiency being 2°·6; from the 27th it was warm, the mean daily excess of these four days being 4°·4. The first 10 days in February were cold, the average daily deficiency of mean temperature was 3°·3; a warm period set in on the 11th of February, which continued with very slight exceptions to the end of the quarter, the average daily excess of temperature for these 49 consecutive days was 5°·3.

The mean temperature of the air for January was 40°·4, being 3°·9 and 2°·1 above the average of 111 years and 41 years respectively; it was 8°·8, 7°·2, and 8°·5 higher than in 1881, 1880, and 1879 respectively, and of the same value, viz., 40°·4, in the year 1878.

Back to 1771 there have been 18 Januarys as warm as this, viz.:

1775	40°·4	1846	43°·7	1866	42°·6	1875	43°·4
1796	45°·3	1851	42°·9	1869	41°·1	1877	42°·7
1804	43°·2	1852	42°·0	1872	41°·3	1878	40°·4
1806	40°·6	1853	42°·4	1873	42°·1		
1834	44°·4	1863	41°·8	1874	41°·7		

The mean temperature of the air for February was 41°·8, being 3°·1 and 2°·4 above the average of 111 years and 41 years respectively; it was 4°·1 higher than in 1881, corresponded with the mean in the year 1880, and 3°·6 higher than in 1879.

Back to the year 1771 there have been but 23 Februarys as warm, viz.:

1775	41°·9	1826	42°·2	1856	42°·0	1871	42°·4
1779	45°·3	1833	42°·4	1861	42°·1	1872	44°·8
1794	44°·7	1846	43°·9	1863	42°·1	1877	43°·5
1809	44°·1	1848	43°·4	1867	44°·7	1878	42°·2
1817	42°·6	1849	43°·2	1868	43°·0	1880	41°·8
1822	43°·3	1850	44°·7	1869	45°·3		

The mean temperature of the air for March was 46°, being 40°·9 and 4°·3 above the average of 111 years and 41 years respectively; it was 3°·4, 1°·7, and 3°·8 higher than in the year 1881, 1880, and 1879 respectively.

Back to 1771 there have been but four instances of a mean temperature in March being as high as 46°, viz.:

1779 it was 47°   1780 it was 49°·2   1822 it was 47°·3;   and in 1841 46°·2

The mean temperature for the quarter was 42°·7, being 4° and 2°·9 above the average of 111 years, and 41 years respectively.

Back to 1771 there have been six instances of the mean temperature of the quarter ending March exceeding 42°, viz.:

1779 it was 42°·4	1834 it was 42°·9	1863 it was 42·6
1822 it was 43°·5	1846 it was 43°·6	1872 it was 43·6

of these four are of higher temperature than in this quarter, viz. in 1822, 1834, 1846, and 1872.

The mean high day temperature of the air in January was 44°·4, being 1°·6 above the average of 41 years; in February it was 47°·7, being 2°·3 above the average, and in March it was 55°·1, being 5°·1 above the average.

The mean low night temperature of the air was in January 35°·3, being 1°·8 above its average; in February it was 36°·2, being 1°·9 above its average, and in March it was 37°·6, being 2°·3 above the average; therefore the high day temperatures and low night temperatures were both very warm, particularly the high day temperatures in March.

The mean daily range of temperature in January was 0°·5 less than the average, and it was 0°·4 and 2°·9 greater respectively in February and March.

The mean temperature of the air in January was 0°·6 higher than in December, in February was 1°·4 higher than in January, and in March was 4°·2 higher than in February.

(From the preceding 41 years observations the decrease of temperature from December to January is 1°·6; the increase of temperature from January to February is 1°·1; from February to March is 2°·3).

From December to January from all stations there was an increase of temperature varying from 0°·3 at Southern to 3°·5 at Northern Stations; from January to February there was an increase at all stations of nearly the same amount viz., 1°, and from February to March there was an increase of from 2° to 5°, at stations south of 54°, and of less than 2°, at extreme northern stations.

The mean reading of the barometer for the month of January at the height of 160 feet above the sea was 30·185 in., being 0·419 in. above the average of 41 years, and 0·475 in. above that of 1881, and 0·019 in. below that of 1880.

Back to 1840 there have only been 6 instances of a mean atmospheric pressure so high as this; viz.,—

1858	30·171 in.	1861	30·011 in.	1876	30·095 in.
1859	30·037 in.	1864	30·044 in.	1880	30·204 in.

1882. Months.	Temperature of Air. Mean.	Air. Diff. from average of 111 years.	Air. Diff. from average of 41 years.	Evaporation. Mean.	Evaporation. Diff. from average of 40 years.	Dew Point. Mean.	Dew Point. Diff. from average of 40 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 40 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 40 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour. Diff. from average of 40 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
Jan. -	40·4	+3·9	+2·1	39·0	+2·2	37·2	+2·5	9·1	−0·5	·222	+0·024	2·6	+0·3
Feb. -	41·8	+4·1	+2·4	40·5	+2·8	38·8	+3·1	11·5	+0·4	·2[illegible]	+0·031	2·8	+0·3
Mar. -	46·0	+4·9	+4·3	43·5	+4·2	40·7	+4·6	17·5	+2·9	·256	+0·041	3·0	+0·5
Means -	42·7	+4·0	+2·9	41·0	+3·1	38·9	+3·4	12·7	+0·9	·2[illegible]	+0·032	2·8	+0·4

1881. Months.	Degree of Humidity. Mean.	Humidity. Diff. from average of 40 years.	Reading of Barometer. Mean.	Barometer. Diff. from average of 40 years.	Weight of a Cubic Foot of Air. Mean.	Weight. Diff. from average of 40 years.	Rain. Amount.	Rain. Diff. from average of 66 years.	Daily Horizontal movement of the Air.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
Jan. -	89	+ 2	30·185	+0·419	559	+ 5	1·35	−0·55	265	11	20	0	18·3	[illegible]
Feb. -	90	+ 5	30·051	+0·268	555	+ 2	1·14	−0·44	292	15	10	3	16·3	45·5
Mar. -	83	+ 1	29·843	+0·097	547	− 3	1·14	−0·43	349	16	10	5	19·0	45·6
Means -	87	+ 3	30·026	+0·261	551	+ 1	Sum 3·63	Sum −1·41	Mean 302	Sum 42	Sum 40	Sum 8	Lowest 16·3	Highest 46·6

Note.—In reading this table it will be borne in mind that the plus sign (+) signifies *above* the average, and that the minus sign (−) signifies *below* the average.

The average duration of the different directions of the wind referred to eight points of the compass, and the duration of each direction in each month in the quarter, were as follow:—

Direction of Wind.	January. 1882.	January. Average.	January. Departure from Average.	February. 1882.	February. Average.	February. Departure from Average.	March. 1882.	March. Average.	March. Departure from Average.
	d.	d.	d.	d.	d.	d.	d.	d.	d.
N.W.	1¾	1¼	+ ½	3	2	+1	3	2¾	+ ¼
N.	0	3	−3	1	3	−2	1½	3¾	−2¼
N.E.	1	3¼	−2¼	1½	3¾	−2¼	0	4	−4
E.	2½	1	+1½	2	2¼	− ¼	0	2¼	−2¼
S.E.	7	2¼	+1¼	2	1¾	+ ¼	1	2¼	−1¼
S.	2¾	1¼	−1½	4	3	+1	2½	2¾	− ¼
S.W.	12¼	9½	+2¾	11	8	+3	11½	7¾	+3¾
W.	3¾	3½	+ ¼	3½	3	+ ½	11½	3¼	+8¼

The plus sign (+) denotes excesses over averages; the largest numbers affected with this sign in the month of January are opposite to S.E. and S.W.; in February to S. and S.W.; and in March to W. and S.W.

The minus sign (−) denotes deficiences below averages. In January the largest numbers are opposite N. and N.E.; in February to N. and N.E.; and in March to N., N.E., and E.

The mean reading of the barometer in February was 30·051 in. being 0·268 in. above the average of 41 years, 0·390 in. above that of 1881, and 0·417 in. above that of 1880.

Back to 1840 there have been but 4 instances of readings as high in February, viz.,

1863	30·141 in.	1878	30·101 in.	1849	30·106 in.	1854	30·041 in.

The mean reading of the barometer in March was 29·843 in. being 0·097 in. above the average of 41 years, and 0·115 in. above that of 1881, and 0·094 in. below that of 1880.

Back to 1840, there have been 11 instances of readings in March exceeding 29·84 in., viz.,

1850	30·039 in.	1856	30·011 in.	1874	30·013 in.	1880	29·937 in.
1852	30·007 in.	1870	29·865 in.	1875	29·954 in.	1850	30·039 in.
1854	30·186 in.	1871	29·876 in.	1878	29·890 in.		

The mean reading of the barometer for the quarter was 30·026 in.

Back to 1840 the highest mean readings have been in the years—

1854	when it was	29·948 in.	1874	when it was	29·919 in.
1858	„	29·926 in.	1878	„	29·990 in.
1859	„	29·890 in.	1880	„	29·925 in.

So that there has been no instance back to 1840, of so high mean readings for the 3 months ending March the nearest approach was in 1878 when it was 29·99.

The atmospheric pressure in January was ·364 in. greater than in December, that in February was less than in January by ·134 in. and that in March was less than in February by ·208 in.

(From the 41 years observations the mean pressure in January is ·029 in. less than in December; is ·017 in. greater in February than in January, and ·037 in. less in March than in February.)

About London the mean daily readings of the barometer were below their averages till the 6th day, on the 3rd day it exceeded 0·5 in.; the lowest reading throughout the month at nearly every station took place on this day. The average daily deficiency of pressure till the 6th was 0·23 in. On the 7th day of January the reading was above its average and continued so till February 24th; with the exception of the 11th and 15th days of February, on which days it was 0·07 in. below its average on both days. The readings in January were very remarkable, the average daily pressure from the 16th to the 19th both inclusive was nearly one inch in excess over the average. On the 18th the reading all over the country was remarkably high, being such that when reduced to the level of the sea, it was about 30·95 in. The average excess of pressure both on the 17th and 18th exceeded one inch, and the average excess daily for the 49 days ending with February 24th was 0·51 in. From February 25th to March 6th, there was a deficiency of pressure of nearly one inch on March 1, and averaging 0·55 in. for the 10 days ending March 6; from March 7 to 19 there was an excess of 0·33 in. daily, and from March 20 to the end of the quarter a deficit of 0·1 in. daily.

Thunderstorm occurred on March 21st at Bolton.

Thunder was heard but lightning was not seen in March; on the 21st at Hull; on the 30th and 31st at Rugby.

Solar halos were seen in January; on the 8th at Bermerside, and on the 28th at Torquay. In February on the 10th and 11th at Torquay, and on the 14th at Cardington. In March on the 6th, 8th, and 20th at Torquay, and on the 18th at Cardington.

Lunar halos were seen on five nights in January, and on seven nights in March.

Aurora borealis was seen in February; on the 16th, 17th, and 20th at Bermerside.

Snow fell on the 1st at Carlisle; on the 7th at Bermerside, and on the 29th at Llandudno, Bermerside, Stonyhurst, and Lancaster.

Hail fell in January on the 1st at Whitchurch; on the 3rd at Guernsey and Truro; on the 6th at Truro and Bolton; on the 7th at Plymouth, Bolton, Bermerside, Stonyhurst, and Carlisle; on the 8th at Torquay; on the 12th, 16th, 17th, 18th, 19th, 20th, 26th at Cardington, and on the 27th at Guernsey and Cardington. In February on the 1st, 2nd, 4th, 5th, 6th, and 7th at Oxford; on the 14th at Bolton and Silloth; on the 15th at Whitchurch and Bolton, and on the 22nd, 24th, and 28th at Oxford. In March on the 1st at Torquay; on the 2nd at Guernsey, Truro, Plymouth, Torquay, Whitchurch, Oxford, Royston, and Cambridge; on the 3rd at Guernsey and Truro; on the 6th at Stonyhurst; on the 8th and 9th at Llandudno; on the 20th at Carlisle; on the 21st at Guernsey, Truro, Plymouth, Torquay, Osborne, Oxford, Royston, Cardington, Lowestoft, Stockton, Llandudno, Hull, Stonyhurst, Lancaster, Silloth, and Carlisle; on the 22nd at Truro, Plymouth, Oxford, Royston, Cardington, Lowestoft, Cambridge, and Hull; on the 23rd at Guernsey; on the 24th at Hull; on the 25th at Stockton; on the 26th at Osborne, Oxford, and Llandudno; on the 29th at Truro; on the 30th at Truro, Cardington, and Stockton, and on the 31st at Torquay and Stockton.

Fog prevailed in January on the 12th at Torquay, Ventnor, Strathfield Turgiss, Whitchurch, Oxford, Cambridge, and Hull; on the 13th at Whitchurch, Lowestoft, and Hull; on the 14th at Cambridge, and Hull; on the 15th at Bolton; on the 16th at Totnes, Oxford, Royston, Cambridge, and Stonyhurst; on the 17th at Guernsey, Strathfield Turgiss, Whitchurch, Oxford, Royston, Somerleyton, Lowestoft, Cambridge, Wolverhampton, Bolton, and Hull; on the 18th at Strathfield Turgiss, Whitchurch, Oxford, Royston, Somerleyton, Lowestoft, Cambridge, Wolverhampton, Bolton, Hull, and Stonyhurst; on the 19th at Torquay, Ventnor, Strathfield Turgiss, Whitchurch, Oxford, Somerleyton, Lowestoft, Cambridge, Bolton, and Stonyhurst; on the 20th at

MONTHLY METEOROLOGICAL TABLE FOR THE QUARTER ENDING MARCH 31st, 1882.

The Observations have been reduced to Mean values by Glaisher's Barometrical and Diurnal Range Tables, and the Hygrometrical results have been deduced from the sixth edition of his Hygrometrical Tables.

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1881. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean Of all Highest.	Mean Of all Lowest.	Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity, Sat. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									
GUERNSEY, Adolphus Collenette, Esq., F.M.S.	234	Jan.	30·088	1·489	53·6	30·8	22·8	45·9	39·8	6·1	42·8	40·6	·254	2·9	0·3	92	555	64·5	37·6	0·4	3	10	8	10	4·1	8·3	15	1·72
		Feb.	29·972	1·723	54·5	30·5	24·0	48·3	39·6	8·7	43·5	40·6	·253	2·9	0·3	90	552	85·3	34·0	0·9	6	8	6	8	4·4	6·3	16	2·31
		Mar.	29·820	1·482	59·3	31·5	27·8	52·4	41·6	10·8	46·6	43·6	·285	3·3	0·4	90	545	95·6	37·9	1·0	5	7	7	12	5·6	5·3	21	2·02
TRURO (Cornwall), C. Barham, Esq., M.D., F.M.S.	43	Jan.	30·290	1·540	56·0	25·0	31·0	50·3	41·2	9·1	45·5	41·2	·239	2·9	0·5	85	555	—	—	2·4	3	11	6	9	—	8·5	13	2·69
		Feb.	30·173	2·040	59·0	31·0	28·0	52·0	40·3	11·7	45·4	42·4	·271	3·1	0·4	89	553	—	—	2·5	4	8	7	9	—	7·5	15	3·17
		Mar.	30·021	1·637	62·0	29·0	33·0	56·0	40·8	15·2	47·0	42·8	·275	3·2	0·5	86	549	—	—	2·1	7	1	7	16	—	6·3	16	1·22
PLYMOUTH (Devon), J. Merrifield, Esq., LL.D., F.R.A.S., F.M.S.	69	Jan.	30·310	1·394	54·0	29·0	25·0	48·0	40·2	8·7	44·6	42·2	·270	3·1	0·3	92	557	—	—	1·4	3	8	11	9	—	7·7	16	2·65
		Feb.	30·183	1·262	55·8	30·1	25·4	50·7	39·3	11·4	44·9	42·1	·268	3·1	0·3	91	554	—	—	1·3	5	8	10	5	—	7·5	11	1·23
		Mar.	30·004	1·610	57·8	33·4	24·4	53·4	40·8	12·6	46·5	42·9	·276	3·2	0·4	88	549	—	—	1·5	7	3	8	13	—	6·2	17	1·07
TOTNES (Devon), T. H. Edmonds, Esq.	167	Jan.	30·329	1·518	55·2	23·0	32·2	48·2	39·2	9·0	43·8	40·5	·253	2·9	0·4	88	558	66·8	35·9	2·0	4	8	11	8	—	7·8	15	2·94
		Feb.	30·153	2·084	57·5	27·1	30·4	51·2	39·3	11·9	44·9	40·9	·256	2·9	0·5	87	551	87·0	34·6	2·1	5	6	5	12	—	8·0	13	3·01
		Mar.	30·004	1·538	62·6	27·0	35·6	55·8	37·3	18·5	45·9	41·0	·258	2·9	0·7	81	550	102·6	32·8	2·4	4	1	8	18	—	5·1	20	1·92
TORQUAY, Babbacombe (Devon), Edwin E. Glyde, Esq., F.M.S.	207	Jan.	30·024	1·662	54·7	27·2	27·5	47·2	39·2	8·0	43·2	39·7	·244	2·8	0·5	87	553	67·5	34·0	1·5	3	8	12	8	4·4	8·1	18	1·73
		Feb.	29·890	2·073	57·8	30·2	27·6	50·4	39·9	10·5	45·0	41·1	·258	2·9	0·5	86	549	87·5	34·1	1·5	2	7	9	10	5·0	7·6	12	2·39
		Mar.	29·727	1·828	63·5	32·2	31·3	54·2	39·5	14·7	46·6	41·2	·260	3·0	0·7	85	544	105·4	32·3	1·5	6	3	7	15	5·4	5·8	17	1·16
VENTNOR, (Isle of Wight) (Royal National Hospital for Consumption), Hartley Sagar, Esq.	150	Jan.	30·278	1·798	53·3	29·4	23·9	46·7	39·4	7·3	42·8	40·1	·249	2·9	0·3	92	558	—	—	0·9	1	9	9	9	6·6	8·2	10	1·57
		Feb.	30·161	1·710	54·7	35·2	19·5	49·3	40·7	8·6	44·2	40·7	·254	2·9	0·4	88	554	—	—	1·1	5	9	5	11	6·0	6·7	9	1·22
		Mar.	29·954	1·672	58·8	31·9	27·9	53·5	41·8	11·7	47·0	42·1	·268	3·3	0·4	91	518	—	—	1·2	4	4	5	17	6·5	4·7	15	0·85
EASTBOURNE (Sussex), Miss W. L. Hall.	13	1881 Oct.	29·926	1·034	62·0	27·9	34·1	53·6	40·9	12·7	46·6	42·5	·272	3·1	0·5	87	556	58·3	33·8	0·3	8	12	4	7	0·9	—	17	2·48
		Nov.	29·942	1·352	61·3	31·7	26·6	55·0	45·1	9·9	50·4	48·6	·343	3·9	0·3	91	543	76·2	38·2	0·4	1	2	11	16	1·6	—	19	3·58
		Dec.	29·927	1·622	54·1	25·0	26·1	46·6	36·6	10·0	42·3	40·1	·249	2·9	0·3	92	552	55·9	19·7	0·1	5	2	10	14	0·7	—	14	4·55
		1882 Jan.	30·293	1·532	52·8	26·3	26·5	45·9	36·1	9·8	41·8	38·2	·231	2·7	0·3	88	558	56·4	30·0	1·4	8	6	7	10	1·2	—	11	1·33
		Feb.	—	—	53·4	28·7	24·7	47·9	38·1	9·8	43·3	39·8	·246	2·8	0·5	88	556	76·6	30·1	0·3	6	1	8	10	1·3	—	10	1·09
		Mar.	—	—	62·5	29·9	32·6	54·3	40·3	14·0	46·8	43·1	·278	3·5	0·5	88	548	98·3	33·6	0·4	7	2	10	12	2·8	—	14	1·32
OSBORNE (Isle of Wight), J. R. Mann, Esq.	172	Jan.	30·177	1·508	52·0	27·7	24·3	45·5	36·7	8·8	41·1	39·8	·245	2·9	0·1	95	558	55·5	35·0	0·2	5	10	9	7	—	7·7	8	1·61
		Feb.	30·069	1·742	55·8	28·7	27·1	49·2	37·6	11·6	42·8	40·6	·254	2·9	0·3	95	551	76·1	31·5	0·2	5	6	8	9	—	6·9	9	1·59
		Mar.	29·856	1·601	63·2	30·6	32·6	55·0	39·3	15·7	46·1	42·8	·275	3·1	0·5	88	546	97·8	37·3	0·2	5	1	11	14	—	4·7	8	0·58
SOUTHBOURNE ON SEA (Hants), T. A. Compton, Esq., M.D., B.A., F.M.S.	95	Jan.	30·259	1·002	53·2	26·8	26·4	46·1	37·9	8·2	42·0	38·7	·235	2·7	0·4	88	559	—	—	1·0	8	6	7	10	—	7·9	10	1·03
		Feb.	30·188	1·558	54·1	28·7	25·4	48·5	39·1	9·4	43·5	39·8	·246	2·8	0·4	88	556	—	—	1·6	7	7	5	9	—	6·4	9	0·91
		Mar.	29·980	1·601	56·2	29·2	27·0	52·0	38·6	13·4	45·4	40·3	·249	2·9	0·4	82	550	—	—	1·2	6	2	7	16	—	5·1	10	1·02
SALISBURY (Wilton House), Wilts, Thomas Challis, Esq.	183	Jan.	30·150	1·670	60·0	20·0	40·0	46·7	32·2	14·5	40·3	37·1	·221	2·6	0·4	89	559	50·4	29·8	1·2	7	6	8	10	—	7·9	14	1·48
		Feb.	30·049	1·754	58·0	21·0	37·0	49·9	33·4	16·5	41·9	38·3	·233	2·7	0·4	88	555	71·0	29·7	1·5	5	5	8	10	—	6·1	13	2·21
		Mar.	29·821	1·618	65·0	21·0	43·0	57·2	34·6	22·6	45·3	41·9	·260	3·1	0·4	80	547	100·7	29·5	1·3	6	2	5	16	—	5·6	16	1·09
BRIGHTON,	[illegible]	Jan.	30·150	1·631	49·6	27·6	22·0	44·4	36·4	8·0	40·8	38·1	·230	2·7	0·3	90	558	—	33·1	0·7	5	9	7	10	—	8·3	8	1·81

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1882. Months.	Pressure of Atmosphere in Month. Mean.	Pressure Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean of all Highest.	Mean of all Lowest.	Mean Daily Range.	Mean Temperature. Air.	Dew Point.	Vapour. Elastic Force.	In a Cubic foot of Air. Mean.	Short of Saturation.	Mean Degree of Humidity, Sat.=100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Minimum on Grass.	Wind. Estimated Strength.	Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
BARNSTAPLE (Devon), William Knill, Esq.	[illegible]	Jan.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8·1	[illegible]	[illegible]	·234	[illegible]	0·3	90	[illegible]	—	—	1·1	2	10	14	5	—	6·4	16	2·56
		Feb.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	·278	3·1	0·4	91	[illegible]	—	—	1·2	4	7	7	10	—	5·3	13	2·72
		Mar.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	548	—	—	1·2	3	3	[illegible]	12	—	4·0	16	1·71
STRATHFIELD TURGISS (Hants), Rev. C. H. Griffith, M.A., F.M.S.	197	Jan.	[illegible]	1·651	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	40·1	[illegible]	·224	2·6	0·3	90	[illegible]	61·2	29·1	0·8	4	3	8	16	1·2	7·9	10	1·31
		Feb.	[illegible]	1·734	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	42·1	[illegible]	[illegible]	2·7	0·4	[illegible]	554	78·2	[illegible]	1·1	3	3	10	12	1·5	7·5	12	1·61
		Mar.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16·8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	82	546	[illegible]	[illegible]	1·3	4	2	[illegible]	17	1·7	5·4	11	0·97
BATH (Somerset), St. Gregory's College, Downside, Rev. F. J. Almond, O.S.B., F.M.S.	[illegible]	Jan.	[illegible]	[illegible]	[illegible]	[illegible]	21·4	[illegible]	[illegible]	9·6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	92	[illegible]	61·6	[illegible]	1·2	6	6	12	7	—	[illegible]	11	2·40
		Feb.	[illegible]	[illegible]	52·4	[illegible]	[illegible]	[illegible]	[illegible]	10·2	41·1	[illegible]	[illegible]	[illegible]	[illegible]	92	546	76·7	[illegible]	1·7	3	1	11	10	—	7·2	11	3·17
		Mar.	[illegible]	1·614	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14·2	[illegible]	41·1	·257	[illegible]	[illegible]	[illegible]	[illegible]	101·0	35·0	1·6	3	2	11	15	—	4·7	20	3·13
MARLBOROUGH (Wilts), Rev. Thomas A. Preston, M.A., F.M.S.	[illegible]	Jan.	[illegible]	1·614	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9·4	[illegible]	[illegible]	·221	2·6	[illegible]	91	[illegible]	[illegible]	[illegible]	0·5	1	7	14	6	—	7·6	10	1·67
		Feb.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11·0	41·0	[illegible]	[illegible]	2·7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6	7	12	—	8·2	10	2·35
		Mar.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	542	[illegible]	31·1	0·9	1	[illegible]	16	11	—	5·4	15	1·86
BLACKHEATH (Kent), James Glaisher, Esq., F.R.S.	[illegible]	Jan.	30·182	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8·0	[illegible]	[illegible]	[illegible]	2·6	[illegible]	[illegible]	[illegible]	55·7	32·2	0·9	0	6	13	12	—	6·1	9	1·16
		Feb.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9·6	42·1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	71·6	[illegible]	0·8	3	4	10	11	—	7·1	6	1·21
		Mar.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0·7	[illegible]	[illegible]	[illegible]	34·4	1·3	[illegible]	9	9	19	—	4·6	10	1·31
WHITCHURCH RECTORY (Oxon), (near Reading), Rev. J. Slatter, M.A., F.M.S.	[illegible]	Jan.	[illegible]	[illegible]	[illegible]	[illegible]	28·1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	0·8	2	7	11	11	—	[illegible]	11	1·24
		Feb.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11·8	41·1	[illegible]	[illegible]	[illegible]	0·2	[illegible]	[illegible]	—	—	0·8	1	2	10	12	—	7·6	8	1·50
		Mar.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17·9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	548	—	—	1·7	3	2	[illegible]	16	—	5·0	12	1·18
CAMDEN SQUARE (London), G. J. Symons, Esq., F.R.S., F.M.S.	[illegible]	Jan.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	35·0	[illegible]	[illegible]	[illegible]	91	[illegible]	51·1	[illegible]	—	4	[illegible]	10	12	—	[illegible]	7	1·80
		Feb.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2·7	[illegible]	84	[illegible]	[illegible]	[illegible]	—	—	—	—	—	—	7·7	8	1·30
		Mar.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	41·1	·279	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	8	2	[illegible]	18	—	5·1	11	1·35
BARNET (Gas Works), F. H. Martin, Esq., C.E.	212	Jan.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	·222	[illegible]	[illegible]	92	[illegible]	[illegible]	[illegible]	0·7	7	4	5	12	—	8·4	9	1·35
		Feb.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2·7	[illegible]	[illegible]	[illegible]	71·0	[illegible]	1·0	[illegible]	3	6	13	—	[illegible]	7	0·77
		Mar.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	·241	2·8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1·7	9	3	[illegible]	16	—	[illegible]	12	1·44
OXFORD (The Observatory), E. J. Stone, Esq., M.A., F.R.S.	210	Jan.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	46·1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2·8	0·2	[illegible]	[illegible]	61·7	[illegible]	[illegible]	[illegible]	[illegible]	15	11	0·2	7·9	12	1·12
		Feb.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	·240	2·8	0·3	[illegible]	554	77·9	[illegible]	[illegible]	3	5	[illegible]	8	0·6	7·6	8	0·95
		Mar.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15·7	[illegible]	[illegible]	·255	2·9	0·6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2	2	[illegible]	16	1·0	5·8	11	1·72
GLOUCESTER COUNTY ASYLUM, E. Toller, Esq., M.R.C.S., F.M.S.	[illegible]	Jan.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2·7	[illegible]	91	[illegible]	54·6	[illegible]	[illegible]	2	[illegible]	1	23	0·7	4·4	6	2·17
		Feb.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	48·2	[illegible]	[illegible]	41·4	[illegible]	[illegible]	2·7	0·4	[illegible]	[illegible]	60·7	22·4	[illegible]	[illegible]	1	1	20	[illegible]	[illegible]	8	1·99
		Mar.	[illegible]	1·674	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17·1	[illegible]	[illegible]	[illegible]	2·8	0·7	81	[illegible]	[illegible]	[illegible]	2·0	4	2	[illegible]	23	0·1	[illegible]	10	1·35
ROYSTON (Hertfordshire), Hale Wortham, Esq., F.R.A.S., F.M.S.	[illegible]	Jan.	30·022	1·642	[illegible]	[illegible]	[illegible]	44·5	[illegible]	[illegible]	[illegible]	37·2	·223	2·6	0·2	92	[illegible]	—	—	—	0	3	11	11	—	7·0	10	1·17
		Feb.	[illegible]	1·721	[illegible]	[illegible]	41·7	[illegible]	[illegible]	[illegible]	41·1	[illegible]	[illegible]	2·6	0·4	[illegible]	[illegible]	—	—	—	3	4	11	10	—	7·2	8	1·76
		Mar.	29·712	[illegible]	64·2	[illegible]	[illegible]	55·2	37·1	[illegible]	[illegible]	40·5	·233	[illegible]	0·7	81	544	—	—	—	3	1	[illegible]	19	—	5·5	12	1·21
BEDFORD, Cardington, Mr. J. McLaren, Assistant to S. Whitbread, Esq., M.P.	[illegible]	Jan.	[illegible]	1·740	[illegible]	[illegible]	26·6	45·1	[illegible]	[illegible]	[illegible]	38·1	·231	2·7	0·3	92	[illegible]	47·9	31·2	1·3	0	[illegible]	11	17	—	7·8	8	1·50
		Feb.	[illegible]	[illegible]	[illegible]	[illegible]	33·6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	·236	2·8	0·2	93	[illegible]	[illegible]	[illegible]	1·4	4	3	[illegible]	13	—	8·0	10	1·60
		Mar.	29·811	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	·247	2·9	0·6	82	547	76·0	[illegible]	2·4	4	0	5	22	—	5·6	10	1·15
CAMBRIDGE (Trinity College), J. W. L. Glaisher, Esq., M.A., F.R.S.	40	Jan.	30·273	1·731	[illegible]	27·4	27·6	45·8	36·8	9·0	41·4	38·7	·235	2·8	[illegible]	91	[illegible]	60·3	30·6	1·0	4	4	15	8	—	7·1	10	1·43
		Feb.	30·159	1·788	58·7	20·9	37·8	48·3	35·9	12·4	[illegible]	38·2	·231	2·7	0·4	88	[illegible]	75·2	29·0	1·0	3	2	15	8	—	7·8	9	1·51
		Mar.	29·913	1·729	66·8	28·8	38·0	57·0	38·1	18·9	46·6	39·8	·245	2·8	0·8	90	548	109·8	29·7	1·3	5	2	11	13	—	4·9	14	1·34
RUGBY (Warwickshire), Stockton, The Rectory, Rev. W. Tuckwell.	289	Jan.	29·874	1·614	52·5	25·0	27·5	46·9	33·9	13·0	40·2	38·4	·232	2·7	0·2	93	554	—	—	0·3	2	4	13	12	6·7	7·5	—	—
		Feb.	29·793	[illegible]	56·0	24·0	32·0	47·3	34·6	12·7	41·3	39·5	·243	2·9	0·2	92	551	—	—	0·4	3	4	11	10	5·0	8·0	11	1·90
		Mar.	29·558	[illegible]	59·0	26·0	35·0	53·7	33·3	20·1	43·4	41·6	·264	3·1	0·2	94	544	—	—	0·6	2	1	13	15	6·9	6·2	13	1·22

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1881. Months.	Pressure of Atmosphere in Month. Mean.	Pressure Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean Of all Highest.	Mean Of all Lowest.	Mean Daily Range.	Mean Temperature. Air.	Dew Point.	Vapour. Elastic Force.	In a cubic foot of Air. Mean.	Short of Saturation.	Mean Degree of Humidity. Sat^n. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Minimum on Grass.	Wind. Estimated Strength.	Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Amount collected.
	feet		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
LOWESTOFT (Suffolk), S. H. MILLER, Esq., F.R.A.S., F.M.S.	89	Jan.	30.231	1.733	53.0	29.0	24.0	41.3	34.7	9.6	40.0	37.5	.225	2.6	0.3	91	551	56.1	31.5	0.5	3	3	7	18	—	7.8	9	1.35
		Feb.	30.093	1.714	52.8	29.2	23.6	45.2	36.7	9.5	41.4	37.5	.234	2.6	0.3	88	557	65.8	31.4	0.7	3	4	6	15	—	6.8	8	1.61
		Mar.	29.852	1.770	62.0	[illegible]	31.0	52.5	37.5	15.0	44.3	41.1	.258	3.0	0.4	91	549	[illegible]	[illegible]	0.7	2	1	5	24	—	5.5	10	1.10
SOMERLEYTON (Suffolk), The Rectory, REV. C. J. STEWARD, F.M.S.	50	Jan.	30.276	1.732	50.7	28.8	21.9	44.4	35.7	8.7	39.9	37.8	.227	2.7	0.2	93	561	—	—	0.9	1	3	13	11	4.6	8.0	12	1.68
		Feb.	30.146	1.718	57.2	26.2	31.0	46.8	35.9	10.9	40.7	38.1	.240	2.7	0.2	90	558	—	—	1.1	3	3	11	11	6.1	7.5	11	1.81
		Mar.	29.983	1.742	62.7	28.2	34.5	53.8	33.7	20.1	43.3	42.4	.270	3.1	0.2	96	551	—	—	1.1	4	2	7	18	6.1	4.4	8	1.24
WOLVERHAMPTON (Staffordshire), Wrottesley, E. SIMPSON, Esq.	509	Jan.	29.772	1.780	54.5	27.9	24.6	44.4	33.7	10.7	39.1	37.1	.221	2.6	0.2	93	553	—	—	—	0	5	13	10	—	8.3	11	2.31
		Feb.	29.634	1.744	53.8	25.5	28.3	45.8	35.9	9.9	40.6	38.2	.230	2.7	0.2	91	549	—	—	—	2	5	11	10	—	8.9	13	2.80
		Mar.	29.433	1.783	61.2	26.3	34.9	51.4	35.3	16.1	42.8	35.2	.240	2.8	0.4	88	543	—	—	—	3	1	14	13	—	7.6	11	1.70
LEICESTER (Town Museum), W. J. HARRISON, Esq., F.G.S.	238	Jan.	30.031	1.832	52.3	30.0	22.3	46.1	35.8	10.3	41.0	36.5	.214	2.5	0.5	83	556	55.5	32.2	0.7	1	2	15	13	—	7.5	13	2.13
		Feb.	29.886	1.831	55.0	27.2	27.8	47.8	37.6	10.2	42.8	40.6	.251	2.9	0.3	92	551	71.1	33.8	0.8	2	2	11	13	—	7.0	13	0.82
		Mar.	29.662	1.790	63.6	27.0	36.4	53.0	37.4	15.6	45.2	38.7	.235	2.7	0.7	78	544	90.5	32.7	1.0	4	0	13	14	—	4.9	—	1.90
NOTTINGHAM (Notts), M. O. TARBOTTON, Esq., C.E., F.G.S., F.M.S.	183	Jan.	30.069	1.756	55.9	26.6	29.3	45.2	35.0	10.2	40.2	38.1	.240	2.7	0.2	92	557	54.6	32.1	0.4	1	3	11	16	1.4	8.4	20	2.25
		Feb.	29.964	1.716	54.8	26.3	28.5	47.4	36.4	11.0	41.7	38.8	.257	2.7	0.3	90	554	63.5	31.0	0.5	2	3	10	13	2.0	7.9	16	1.34
		Mar.	29.720	1.772	63.6	25.2	38.4	53.8	35.7	18.1	44.2	39.0	.238	2.7	0.6	81	546	83.5	33.1	0.6	2	0	11	18	2.3	6.5	22	2.27
HOLKHAM (Norfolk), JOHN DAVIDSON, Esq., Assistant to the Earl of Leicester.	39	Jan.	30.234	1.773	53.2	25.2	28.0	44.3	31.9	12.4	39.0	35.6	.209	2.4	0.4	88	562	49.1	27.3	1.3	0	2	20	9	—	7.4	—	1.87
		Feb.	30.117	1.700	55.5	17.3	38.2	46.5	32.1	14.4	39.9	35.3	.214	2.5	0.4	87	559	62.2	25.4	1.7	2	1	18	7	—	7.8	8	1.55
		Mar.	29.880	1.776	60.3	23.6	36.7	52.6	33.6	19.0	43.3	39.3	.242	2.8	0.5	82	550	87.9	28.0	2.1	3	1	15	10	—	5.9	5	1.22
LLANDUDNO (Carnarvonshire), JAMES NICOL, Esq., M.D.	197	Jan.	30.158	1.750	55.5	33.1	22.4	49.6	39.8	9.8	44.4	40.3	.250	2.9	0.5	86	551	—	—	0.9	0	3	6	22	—	6.9	15	3.19
		Feb.	30.024	1.910	—	31.8	—	47.7	40.8	6.9	44.7	39.9	.247	2.8	0.5	84	551	—	—	0.9	1	3	9	15	—	7.8	15	1.61
		Mar.	29.820	1.850	54.3	34.0	22.3	52.1	41.3	10.8	46.6	40.4	.232	2.9	0.7	80	546	—	—	1.1	2	1	8	20	—	6.1	17	2.02
LIVERPOOL, The Observatory, JOHN HARTNUP, Esq., F.R.A.S.	197	Jan.	30.020	1.793	54.1	31.0	21.1	46.2	38.4	7.8	42.1	38.8	.238	2.7	0.4	88	555	—	—	—	1	5	15	10	—	7.7	14	2.22
		Feb.	29.917	1.855	56.0	28.7	27.3	47.4	40.0	7.4	43.4	40.2	.249	2.9	0.4	88	551	—	—	—	1	6	11	10	—	8.1	11	1.27
		Mar.	29.715	1.829	56.8	33.5	23.3	51.0	41.6	9.4	45.8	41.1	.259	2.9	0.6	81	515	—	—	—	3	2	8	18	—	7.2	13	2.25
BOLTON, Sharples (Lancashire), REV. T. MACKERETH, F.R.A.S., F.M.S.	500	Jan.	29.691	1.701	51.6	30.0	21.6	43.7	35.5	8.2	39.9	37.2	.222	2.6	0.2	91	551	45.4	29.4	1.5	1	4	13	13	2.6	9.2	19	4.35
		Feb.	29.588	1.804	53.8	28.0	25.8	45.7	37.2	8.5	41.3	37.7	.225	2.6	0.5	88	547	44.8	30.5	1.9	3	5	11	9	3.2	8.3	14	3.17
		Mar.	29.369	1.829	58.4	27.9	30.5	49.3	37.4	11.9	42.7	38.8	.236	2.7	0.5	86	542	57.3	30.5	2.3	2	3	11	15	3.5	7.1	20	4.41
HALIFAX, Bermerside Observatory (Yorkshire), E. J. CROSSLEY, Esq., F.R.A.S.	530	Jan.	29.717	1.790	52.4	26.0	26.4	43.3	35.8	7.5	39.3	37.6	.226	2.7	0.2	94	552	57.4	32.7	0.7	2	4	11	14	—	8.0	17	4.47
		Feb.	29.581	1.798	56.5	28.0	28.5	46.6	36.5	10.1	41.1	37.9	.228	2.6	0.4	89	517	67.4	31.6	0.8	2	3	9	14	—	7.9	12	2.18
		Mar.	29.368	1.770	60.0	31.5	28.5	49.0	37.0	12.0	43.0	38.3	.236	2.7	0.5	85	541	69.1	31.2	1.3	2	2	12	15	—	6.8	18	3.50
HULL (Yorkshire), The People's Park, MR. E. PEAKE.	12	Jan.	30.271	1.768	52.0	29.0	23.0	43.6	34.7	8.9	40.3	35.2	.205	2.4	0.8	83	561	48.5	33.0	1.2	1	4	14	12	0.4	7.2	10	2.12
		Feb.	30.124	1.708	54.0	27.0	27.0	47.1	37.3	9.8	42.4	37.1	.221	2.5	0.6	82	554	59.8	33.1	1.5	3	3	9	13	0.6	5.7	10	1.56
		Mar.	29.899	1.692	62.0	28.0	34.0	52.1	35.2	16.9	44.6	37.6	.226	2.6	0.7	76	550	76.4	32.1	1.5	2	1	7	21	0.6	4.5	13	1.68
STONYHURST (Lancashire), REV. S. J. PERRY, F.R.S., F.M.S., F.R.A.S.	343	Jan.	29.878	1.560	50.2	32.6	17.6	45.6	37.2	8.4	40.9	38.0	.228	2.7	0.3	90	553	58.1	34.6	—	1	2	9	19	—	9.5	17	4.03
		Feb.	29.752	1.864	56.0	26.6	29.4	47.4	37.8	9.6	42.2	37.5	.235	2.6	0.5	81	549	64.6	34.8	—	2	2	8	16	—	9.2	19	3.37
		Mar.	29.598	1.779	59.0	29.1	29.9	50.9	38.5	12.4	43.6	39.0	.217	2.8	0.4	87	543	91.1	35.0	—	2	2	5	22	—	7.6	22	5.41
BRADFORD (Yorkshire), J. McLANDSBOROUGH, Esq., C.E., F.G.S.	366	Jan.	29.848	1.826	52.0	33.0	19.0	45.6	37.9	7.7	41.9	37.4	.226	2.6	0.5	86	552	52.4	—	1.1	2	5	10	14	—	7.5	16	3.84
		Feb.	29.738	1.708	54.0	27.6	26.4	47.5	39.2	8.3	43.0	39.5	.242	2.8	0.4	87	548	56.4	—	1.2	3	1	11	13	—	7.7	11	2.31
		Mar.	29.478	1.710	59.8	32.7	27.1	51.1	39.6	11.5	44.8	39.2	.239	2.8	0.6	81	541	61.5	—	1.4	2	2	11	16	—	6.4	19	2.88
LEEDS (Yorkshire), The Philosophical Hall, HENRY CROWTHER, Esq.	187	Jan.	30.108	1.800	59.0	33.0	26.0	43.7	38.6	7.1	42.8	37.8	.227	2.6	0.6	83	555	49.3	—	1.4	1	4	8	18	—	7.1	11	2.49
		Feb.	29.975	1.764	50.0	27.0	23.0	48.4	39.7	8.7	44.5	38.7	.233	2.7	0.7	80	551	55.5	—	1.4	2	4	7	15	—	7.3	9	1.64
		Mar.	29.733	1.750	63.0	29.0	36.0	53.0	40.6	13.3	46.6	40.4	.252	2.9	0.7	80	546	61.3	—	1.3	4	2	6	19	—	6.1	14	1.70

Names of Stations and Observers.	Height of Station above Sea Level.	Months.	Barometer (Month): Mean.	Range.	Thermometer (Month): Highest.	Lowest.	Range.	Mean of all Highest.	Mean of all Lowest.	Daily Range.	Air.	Dew Point.	Elastic Force.	In a cubic foot of Air: Mean.	Short of Saturation.	Mean Degree of Humidity. Sat. = 100	Mean Weight of cubic foot of Air.	Thermometer: Maximum in Rays of Sun.	Minimum on Grass.	Estimated Strength.	Relative Proportion of: N.	E.	S.	W.	Mean Amount Ozone.	Mean Amount Cloud.	Number of Days it fell.	Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
LANCASTER (Southfields), William Roper, Esq.	114	Jan.	30·113	1·378	50·0	23·0	27·0	45·4	37·2	8·2	41·6	37·3	·223	2·5	0·5	86	557	—	—	—	—	—	—	—	—	—	17	3·42
		Feb.	30·016	1·662	55·0	30·0	25·0	46·5	38·8	7·7	42·6	38·0	·229	2·6	0·5	85	551	—	—	—	—	—	—	—	—	—	19	2·81
		Mar.	29·776	1·720	55·0	31·0	24·0	48·9	39·0	9·9	43·5	39·5	·244	2·7	0·5	86	548	—	—	—	—	—	—	—	—	—	20	3·40
COCKERMOUTH (Cumberland), H. Dodgson, Esq., M.D., F.M.S., F.R.A.S.	146	Jan.	30·045	1·868	54·0	32·5	21·5	46·6	39·9	6·7	43·3	39·2	·239	2·8	0·5	85	551	57·7	31·8	0·6	2	2	12	15	2·2	8·6	19	3·97
		Feb.	29·939	1·874	55·6	27·3	28·3	47·9	38·9	9·0	43·5	39·9	·248	2·9	0·4	87	551	74·2	34·4	0·7	2	3	9	14	2·2	8·3	17	3·87
		Mar.	29·632	1·758	53·6	31·0	22·6	49·2	39·5	9·7	44·0	40·3	·250	2·9	0·4	86	516	84·3	32·3	0·8	2	3	10	16	2·2	7·5	22	4·29
SILLOTH (Cumberland), "The Rectory," Rev. F. Redford, M.A., F.R.A.S., F.M.S.	28	Jan.	30·169	2·006	53·0	32·0	21·0	45·9	38·9	7·0	42·7	39·0	·237	2·7	0·4	86	556	61·8	36·4	1·5	1	4	11	15	8·1	7·7	16	1·96
		Feb.	30·069	1·966	56·4	27·1	29·3	47·3	39·4	7·9	43·3	40·4	·252	2·9	0·4	90	553	75·1	36·9	1·5	3	3	9	13	8·4	7·0	15	2·40
		Mar.	29·894	1·685	53·5	32·0	21·5	48·9	40·1	8·8	43·7	39·9	·246	2·8	0·4	86	549	89·1	36·7	1·9	3	4	7	17	8·7	6·6	23	3·00
CARLISLE, Spital (Cumberland), Isaac Cartmel, Esq., F.M.S.	114	Jan.	30·070	1·826	52·8	30·0	22·8	46·2	36·7	9·5	41·9	39·2	·240	2·8	0·3	92	555	54·2	30·5	1·2	0	13	6	12	4·6	8·5	16	1·90
		Feb.	29·952	1·784	56·8	25·7	31·1	48·7	37·5	11·2	43·0	39·0	·238	2·7	0·5	86	552	62·1	31·0	1·4	2	9	7	10	4·1	8·9	12	1·80
		Mar.	29·694	1·656	57·5	30·5	27·0	51·1	37·8	13·3	44·2	39·2	·240	2·7	0·6	80	546	76·7	30·9	1·6	0	5	7	19	5·0	7·5	19	2·30

Second Rain-gauges are placed—

		Jan.	Feb.	Mar.	Total in Quarter.
At Beachy Head, at the height of 515 feet *above the sea*; the amount collected was		0·92 inches.	1·21 inches.	0·93 inches.	3·09 inches.
" " "	495	0·95 "	1·44 "	0·95 "	3·34 "
" Oxford, "	22	1·14 "	0·94 "	1·62 "	3·70 "
" Cardington, "	36	1·44 "	1·11 "	1·45 "	4·00 "
" Nottingham, "	39	2·00 "	1·18 "	2·03 "	5·21 "
" Holkham, "	4	1·73 "	1·45 "	0·92 "	4·10 "

Fog, continued from page 67.
Somerleyton, Lowestoft ...

D,

NAMES OF STATIONS.

1882.

Guernsey, Truro, Plymouth, Totnes, Torquay, Ventnor, Osborne, Southbourne, Salisbury, Brighton, Barnstaple, Bath, Strathfield Turgiss, Marlborough, Whitchurch, Blackheath, Camden Square, Barnet, Oxford, Gloucester, Royston, Bedford, Cambridge, Rugby, Lowestoft, Somerleyton, Wolverhampton, Leicester, Nottingham, Holkham, Llandudno, Liverpool, Bolton, Halifax, Hull, Stonyhurst, Bradford, Leeds, Lancaster, Cockermouth, Silloth, Carlisle

The highest temperature
The lowest temperature
The greatest daily
The least daily range
The greatest number
The least number
The greatest fall
The least falls of

... frequent three pre- ...ess of the ... from the ... Guernsey, ...nd, which ...rse. This ...bserver at ...ys, houses ...oken of as ... observers ...ne country ... gale after ...t Hull the ... there was ...ng an inch ...yhurst, on ...d,; and on ...month was ...The atmo- ...age. The ... at any of ... exception ...e pressure ...eather was ...nd bad for ... very slight ...was below ...ing 3°·9; ... days was ...mperature ... excess of ... the excep- ... cold, and ... instances ...n the 5th ...ds, and on ... above the ...year 1881, ...he average ...881, 1880, ... average of ...881, 1880, ... average of ...he average ...°·3, being ... above its ...being 1°·0 ...ge, in May ...d in June ... in May it

PARALLELS
LATITUDE.

Guernsey
Between the latitudes: 50° and, 51° and, 52° and, 53° and, 54° and
Mean for the Quarter, 50° to 55°

Rain. | Amount of | Amount of | Wind. Relative Proportion of | Mean Reading of Thermometer | Vapour. In a cubic foot of Air. | Mean Temperature. | Temperature of Air in Month. Mean | Pressure of Atmosphere in Month. | Year 1881. | Station | Names of Stations and

Meteorological Tables, Quarter ending March 31st, 1882.

Mean Pressure of dry Air reduced to the level of the Sea.	Highest Reading of the Thermometer.	Lowest Reading of the Thermometer.	Range of Temperature in the Quarter.	Mean of all Highest.	Mean of all Lowest.	Mean Monthly Range of Temperature.	Mean Daily Range of Temperature.	Mean Temperature of the Air.	Mean Temperature of the Dew Point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Mean Reading of Maximum in Rays of Sun.	Mean Reading of Minimum on Grass.	Mean Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.
in.	°	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°							
29·922	[illegible]	[illegible]	[illegible]	[illegible]	40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3·1	0·3	91	551	81·7	[illegible]	0·9	5	[illegible]	7	10	1·7	6·6
29·94	[illegible]	[illegible]	[illegible]	[illegible]	40	[illegible]	12·0	[illegible]	42·1	[illegible]	[illegible]	0·3	[illegible]	552	—	—	2·4	5	7	7	11	—	7·[illegible]
29·97	[illegible]	[illegible]	[illegible]	[illegible]	40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	90	552	—	—	1·4	5	5	10	9	—	7·[illegible]
30·02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	554	87·[illegible]	34·[illegible]	[illegible]	4	5	8	13	—	7·[illegible]
29·961	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11·1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	85	549	87·9	[illegible]	1·5	4	6	9	11	4·9	7·[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	41·7	[illegible]	[illegible]	[illegible]	[illegible]	90	55[illegible]	—	—	1·1	4	7	6	12	6·4	6·5
29·964	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0·4	98	551	76·6	[illegible]	0·2	5	6	9	10	—	6·4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	555	—	—	1·7	7	5	6	12	—	6·[illegible]
29·971	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17	[illegible]	[illegible]	·241	[illegible]	[illegible]	[illegible]	554	75·[illegible]	[illegible]	1·8	7	4	7	12	—	7·[illegible]
30·011	[illegible]	24·[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	87	[illegible]	—	[illegible]	[illegible]	[illegible]	[illegible]	7	12	—	7·[illegible]
29·921	67·0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10·7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	90	553	—	—	1·2	3	7	11	9	—	5·2
29·[illegible]30	[illegible]	[illegible]	[illegible]	47	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1·5	4	1	11	11	—	6·[illegible]
29·96[illegible]	[illegible]	21	42·1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	86	[illegible]	[illegible]	[illegible]	1·0	4	5	9	15	1·[illegible]	6·[illegible]
29·95[illegible]	64·1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	41·[illegible]	[illegible]	[illegible]	2·7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0·8	3	4	12	11	—	7·1
29·967	61·7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	1·1	5	4	[illegible]	13	—	6·9
29·9[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2·7	[illegible]	84	[illegible]	73·[illegible]	[illegible]	[illegible]	2	3	11	14	—	6·[illegible]
29·982	[illegible]	24·[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	551	[illegible]	[illegible]	—	—	—	—	—	—	6·[illegible]
29·9[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2·7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6	11	—	7·4
[illegible]	61·[illegible]	24·[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12	0·6	7·[illegible]
[illegible]	[illegible]	25·[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	551	[illegible]	[illegible]	1·1	[illegible]	[illegible]	[illegible]	22	0·6	4·[illegible]
29·952	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12·[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	87	55[illegible]	—	—	—	[illegible]	[illegible]	11	14	—	[illegible]
29·91	61·[illegible]	22·[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	42	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1·7	3	[illegible]	[illegible]	17	—	7·1
29·920	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14	10	—	6·6
29·85[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	0·4	[illegible]	[illegible]	16	9	6·2	7·[illegible]
29·920	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2·7	[illegible]	91	[illegible]	72·[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6	15	—	6·7
29·922	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	1·[illegible]	3	[illegible]	10	14	5·6	6·[illegible]
29·950	61·2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	91	[illegible]	—	—	—	[illegible]	[illegible]	11	11	—	8·3
29·86[illegible]	[illegible]	27[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	81	[illegible]	[illegible]	[illegible]	0·8	2	1	[illegible]	13	—	6·[illegible]
29·86[illegible]	[illegible]	25·[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0·4	[illegible]	2	11	16	1·[illegible]	7·6
29·86[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	86	[illegible]	69·4	[illegible]	1·7	2	1	18	9	—	7·6
29·910	[illegible]	[illegible]	21·[illegible]	[illegible]	[illegible]	—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	83	[illegible]	—	—	1·[illegible]	1	2	8	19	—	6·[illegible]
29·85[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	87	[illegible]	—	—	—	2	4	11	13	—	7·[illegible]
29·87[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	547	[illegible]	[illegible]	1·1	2	4	12	12	[illegible]	8·2
29·80[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	41·1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	547	[illegible]	[illegible]	0·[illegible]	2	3	[illegible]	14	—	7·[illegible]
29·88[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11·[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	55[illegible]	[illegible]	[illegible]	1·4	2	[illegible]	10	15	[illegible]	[illegible]
29·87[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10·2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	548	[illegible]	[illegible]	—	2	2	7	19	—	8·[illegible]
29·858	[illegible]	27·[illegible]	[illegible]	18·1	[illegible]	24·2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	85	547	[illegible]	—	1·5	2	3	11	14	—	7·[illegible]
29·85[illegible]	65·[illegible]	27·[illegible]	[illegible]	49·[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	81	551	[illegible]	—	1·4	2	3	7	17	—	6·8
29·862	[illegible]	23·[illegible]	[illegible]	46·[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	86	55[illegible]	—	—	—	—	—	—	—	—	—
29·86[illegible]	[illegible]	27·[illegible]	[illegible]	47·[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2·9	[illegible]	[illegible]	55[illegible]	72·[illegible]	[illegible]	0·7	2	3	10	[illegible]	[illegible]	8·1
29·79[illegible]	[illegible]	27·1	[illegible]	47·1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2·8	[illegible]	[illegible]	551	75·[illegible]	[illegible]	1·6	2	1	9	[illegible]	8·1	7·1
29·79[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	551	61	[illegible]	1·4	1	9	7	14	4·[illegible]	8·[illegible]

[illegible] *tures of the air* were at Bournemouth, 67·[illegible]; Bedford, 66·[illegible]; Salisbury, 6[illegible]; and Blackheath, Leeds, and Lancas[illegible]

[illegible] *atures of the air* were at Holkham, 17·[illegible]; Barnet, 18·[illegible]; Salisbury, 20·[illegible]; and Cambridge, 20·9.

[illegible] *ranges of temperature* were at Rugby, 1[illegible]·4; Holkham, 15·3; Barnet, 14·[illegible]; and Gloucester, 13·8.

[illegible] *es of temperature* were at Sal[illegible], 7·9; Liverpool, [illegible]·2; Guernsey and Cockermouth, 8·5; and Lancaster, [illegible]

[illegible] *er of days of rain* were at Nottingham, Stonyhurst, and Cockermouth, 58; Lancaster, 5[illegible]; and Bolton, 53.

[illegible] *of days of rain* were at Gloucester, 24; Osborne and Blackheath, 25; and Camden Square, 26.

[illegible] *of rain* were at Stonyhurst, 12·83 inches; Cockermouth, 12·13 inches; Bolton, 11·2[illegible] inches; and Halifax, 10·1[illegible]

[illegible] *rain* were at Spitalbourne, 2·9[illegible] inches; Barnet, 3·[illegible] inches; Ventnor, 3·61 inches; and Osborne, 3·67 inches.

Quarterly Meteorological Table for different Parallels of Latitude.

Names of Stations and [illegible]	Mean Pressure of dry Air reduced to the level of the Sea.	Mean of all Highest Readings of the Thermometer.	Mean of all Lowest Readings of the Thermometer.	Mean Range of Temperature in the Quarter.	Mean of all Highest.	Mean of all Lowest.	Mean Monthly Range of Temperature.	Mean Daily Range of Temperature.	Mean Temperature of the Air.	Mean Temperature of the Dew Point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Mean Reading of Maximum in Rays of Sun.	Mean Reading of Minimum on Grass.	Mean Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.
	in.	°	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°							
-	29·922	[illegible]	[illegible]	[illegible]	48·9	40·[illegible]	24·[illegible]	8·[illegible]	44·[illegible]	41·6	·[illegible]4	3·0	0·3	91	551	81·7	25·8	0·9	5	8	7	10	1·7	6·6
51° -	29·9[illegible]8	60·7	29·9	31·8	50·7	39·[illegible]	27·[illegible]	11·[illegible]	45·[illegible]	41·1	·258	3·0	0·4	88	553	84·1	[illegible]	1·4	3	6	8	11	5·7	6·9
52° -	29·958	64·1	25·6	40·8	49·6	35·5	32·4	15·1	42·8	39·[illegible]	·2[illegible]	2·8	0·4	88	553	71·1	29·6	1·[illegible]	4	4	9	14	[illegible]	6·5
53° -	29·915	62·4	28·7	38·7	48·6	35·2	28·5	13·1	41·8	38·5	·2[illegible]	2·8	0·4	89	554	69·7	30·8	1·0	3	3	12	13	4·6	7·1
54° -	29·880	59·1	27·3	31·9	47·8	38·2	26·4	9·6	45·0	[illegible]8·6	·2[illegible]5	2·7	0·5	85	550	69·6	32·8	1·3	2	3	10	15	1·8	7·4
55° -	29·797	56·5	26·7	29·8	48·0	35·7	28·3	9·2	43·3	39·5	·24[illegible]	2·8	0·4	86	551	70·[illegible]	[illegible]7	1·2	2	5	9	15	5·1	7·8
[illegible]ar 1879	29·648	58·9	16·4	42·5	42·3	31·6	31·8	10·7	36·6	33·3	·192	2·3	0·3	87	554	62·4	27·6	1·1	7	10	6	7	4·2	7·[illegible]
„ 1880	29·837	60·6	17·8	43·0	46·6	34·6	31·7	12·0	40·4	35·4	·218	2·5	0·4	86	553	70·2	29·8	1·2	4	10	8	8	4·1	6·4
„ 1881	29·677	58·[illegible]	[illegible]6·8	51·[illegible]	42·1	30·8	25·0	11·6	36·1	32·7	·180	2·2	0·[illegible]	8[illegible]	554	66·8	26·6	1·2	7	9	5	9	—	6·9
„ 1882	29·907	60·6	25·6	35·0	48·9	37·6	29·7	11·[illegible]	45·1	39·4	·243	2·8	0·4	87	551	71·9	[illegible]27	1·2	3	4	10	14	3·6	7·1

METEOROLOGY OF ENGLAND,

DURING THE QUARTER ENDING JUNE 30, 1882.

Remarks on the Weather during the Quarter ending June 30th, 1882.

By James Glaisher, Esq., F.R.S., *&c.*

The weather in April was generally warm till towards the end of the month, with frequent rain, the total being in excess of the average, but not more than was needed, the three preceding months having been drier than usual. The atmospheric pressure was in excess of the average till the 10th, and generally in defect afterwards. The prevailing winds were from the S., S.W., and W.

On the 28th, there were violent gales of wind and squalls passing over Jersey and Guernsey, and on the 29th a severe gale passed over the South of Wales and the South of England, which proved to be very injurious to fruit trees and the foliage of trees throughout its course. This gale was thought to be in some places as severe as that of October 14th, 1881. The observer at Osborne says, twelve large trees were overturned; the observer at Southbourne says, houses were unroofed. At all places the leaves of trees on the S.W. or windward side was spoken of as blackened, as if by frost, or as if scorched by fire, this effect was attributed by several observers to saline matter carried by the wind. The gale entirely changed the appearance of the country over which it passed, but it did not extend far north. At Cambridge there was a gale after 3 p.m.; at Oxford a storm from 5 p.m. to 9 p.m.; at Lowestoft a gale after 4 p.m.; at Hull the day was fine with showers; at Bradford the day was fine throughout; at Stonyhurst there was a snow storm, and snow fell at Liverpool and Bolton. The instances of rain exceeding an inch in one day, were on the 1st at Plymouth, on the 12th at Totnes, on the 13th at Stonyhurst, on the 25th at Caterham and London, on the 29th at Wrottesley, Bolton, and Bradford, and on the 30th at Halifax.

The weather in May with the exception of about a week in the beginning of the month was warm and genial. The fall of rain at most places was less than the average. The atmospheric pressure, except from the 20th to the 26th, was generally above the average. The month was favourable to all growing crops, grass abundant; there was no instance at any of the stations of a fall of rain to the depth of an inch on one day during the month.

The weather in June was cold and unseasonable throughout, the temperature, with the exception of 2 or 3 days at the beginning of the month, was below its average. The atmospheric pressure was below its average from the 3rd to the 14th and from the 18th to the 24th; the weather was variable; the fall of rain was in excess of the average, it was a wet, ungenial month, and bad for hay making, and proved to be the coldest June since 1871.

About London the mean daily temperature of the air was above its average with very slight exception till the 24th day, and the mean daily excess of these 24 days was 2°·3; it was below its average from April 25th to May 1st; the average daily deficiency of these 7 days being 3°·9; from May 2nd to May 13th it was generally warm, the mean daily excess of these 12 days was 2°·3; from May 14th to 18th it was cold every day, the mean daily deficiency of temperature being 2°·6; from May 19th to the end of the month it was warm, the average daily excess of temperature of these 13 days being 2°·5; from June 1st to the end of the month, with the exception of the 3rd, 4th, and 7th, which were slightly above their average, every day was cold, and the average daily deficiency of mean temperature for these 30 days was 3°·4. The instances of rain exceeding an inch in one day were on the 3rd at Bolton and Stonyhurst, on the 5th at Plymouth, on the 13th at Bolton and Stonyhurst, on the 22nd at Bradford and Leeds, and on the 23rd at Nottingham and Bermerside.

The mean temperature of the air for April was 47°·9, being 1°·8 and 0°·8 above the average of 111 years and 41 years respectively; it was 2°·0, higher than in the year 1881, 0°·8 higher than in 1880, and 4°·7 higher than in 1879.

The mean temperature of the air for May was 54°·5, being 2°·0 and 1°·9 above the average of 111 years and 41 years respectively; it was 0°·4, 1°·9, and 6°·1 higher than in 1881, 1880, and 1879, respectively.

The mean temperature of the air for June was 56°·5, being 1°·7 and 2°·4 below the average of 111 years and 41 years respectively; it was 2°·2, 1°·0, 0°·4 lower than in the year 1881, 1880, and 1879, respectively.

The mean temperature for the quarter was 53°·0, being 0°·7 and 0°·1 above the average of 111 years, and 41 years, respectively.

The mean high day temperature of the air in April was 57°·6, being the same as the average of 41 years; in May it was 66°·2, being 2°·0 above the average, and in June it was 66°·3, being 4°·7 below the average.

The mean low night temperature of the air in April was 39°·8, being 0°·6 above its average; in May it was 44°·2, being 0°·5 above its average, and in June it was 48°·9, being 1°·0 below its average; therefore the high day temperature in April was that of its average, in May was a little above its average, and in June was nearly 5° below.

The low night temperature in both April and May was a little above the average, and in June was about 1° colder than the average.

The mean daily range of temperature in April was 0°·6 smaller than the average, in May it was 1°·6 greater than the average, and in June it was 3°·7 smaller than the average.

The mean temperature of the air in April was 1°·9 higher than in March, in May was 6°·6 higher than in April, and in June was 2°·0 higher than in May.

(From the preceding 41 years observations the increase of temperature from March to April is 5°·3, from April to May is 5°·6, and from May to June is 6°·2).

From March to April from all stations there was an increase of temperature; of 1°·5 at station South of latitude 51°, of 1°·9 at stations between latitude 51° and 53° and gradually decreasing from 1°·9 at latitude 53° to 0°·2 at extreme northern stations; from April to May there was an increase at all stations of nearly the same amount, the mean value was 5°·7, and the mean increase from May to June was 2°·2, being of nearly this value at all stations.

1882. Months.	Temperature of: Air. Mean.	Air. Diff. from average of 111 years.	Air. Diff. from average of 41 years.	Evaporation. Mean.	Evaporation. Diff. from average of 41 years.	Dew Point. Mean.	Dew Point. Diff. from average of 41 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 41 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 41 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour in a Cubic Foot of Air. Diff. from average of 41 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
April -	47·9	+1·8	+0·8	45·4	+1·4	42·1	+1·9	17·8	−0·6	·271	+0·018	3·1	+0·2
May -	51·5	+2·0	+1·9	[illegible]	+1·7	46·6	+1·6	22·0	+1·6	·318	+0·020	3·6	+0·1
June -	56·5	−1·7	−2·4	[illegible]	−1·2	50·4	−0·2	17·4	−3·7	·366	+0·004	4·1	0·0
Means -	53·0	+0·7	+0·1	49·7	+0·6	46·5	+1·1	19·1	−0·9	·318	+0·014	3·6	+0·1

1882. Months.	Degree of Humidity. Mean.	Degree of Humidity. Diff. from average of 41 years.	Reading of Barometer. Mean.	Reading of Barometer. Diff. from average of 41 years.	Weight of a Cubic Foot of Air. Mean.	Weight of a Cubic Foot of Air. Diff. from average of 41 years.	Rain. Amount.	Rain. Diff. from average of 63 years.	Daily Horizontal movement of the Air.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Number of Nights it was Between 30° and 40°.	Number of Nights it was Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
April -	81	+ 5	29·692	−0·132	540	− 5	2·40	+0·65	251	11	16	3	24·1	41·5
May -	75	0	29·87[illegible]	+0·0[illegible]	[illegible]	− 3	1·77	−0·71	267	7	12	12	23·7	47·2
June -	80	+ 6	29·7[illegible]	−0·071	[illegible]	+ 1	[illegible]	[illegible]	325	0	5	25	33·0	53·2
Means -	79	+ 1	29·737	−0·016	537	− 2	Sum 6·13	Sum +0·30	Mean 315	Sum 18	Sum 33	Sum 40	Lowest 23·7	Highest 53·2

Note.—In reading this table it will be borne in mind that the plus sign (+) signifies *above* the average, and that the minus sign (−) signifies *below* the average.

The average duration of the different directions of the wind referred to eight points of the compass, and the duration of each direction in each month in the quarter, were as follow:—

Direction of Wind.	April. 1882.	April. Average.	April. Departure from Average.	May. 1882.	May. Average.	May. Departure from Average.	June. 1882.	June. Average.	June. Departure from Average.
	d.	d.	d.	d.	d.	d.	d.	d.	d.
N.W.	½	2¼	−1¾	2½	1½	+1	3¾	2¼	+1½
N.	1	4¼	−3¼	2¼	4¾	−2½	¾	3¾	−3
N.E.	5	6¼	−1¼	7½	7½	0	¼	3¾	−3½
E.	3	3½	− ½	2	2¼	− ¼	2¼	2¼	0
S.E.	2¼	2¼	0	3	1¾	+1¼	1¼	1¾	− ½
S.	3	2½	+ ½	5¾	2¾	+3	3¾	2¼	+1½
S.W.	10	6¼	+3¾	5½	8	−2½	10¼	10	+ ¼
W.	5	2¾	+2¼	2½	2¼	+ ¼	7½	4	+3½

The plus sign (+) denotes excesses over averages; the largest numbers affected with this sign in the month of April are opposite to S.W. and W.; in May to S. and S.E.; and in June to W. and S.

The minus sign (−) denotes deficiencies below averages. In April the largest numbers are opposite N. and N.W.; in May to S.W. and N.; and in June to N.E. and N.

About London the mean daily readings of the barometer were below their averages till the 2nd day. The average daily deficiency of the two days was 0·07 in. On the 3rd of April the reading was above its average and continued so till the 10th, the average daily excess was 0·25 in. From the 11th till the 18th there was a deficiency of pressure (exceeding six tenths of an inch on the 13th and 14th), and for those eight days averaging 0·32 in. daily. From the 19th till the 21st the average excess daily was 0·17 in. From April 22nd till May 5th the average daily deficiency was 0·34 in. From May 6th till the 19th the average daily excess for these 14 days was 0·33 in. From the 20th to 26th the daily deficiency was 0·21 in. From May 27th to June 2nd the average

excess daily was 0·26 in. From the 3rd to the 14th the average deficiency daily was 0·19 in. From the 15th to the 17th the average excess daily was 0·12 in. From the 18th to 24th the average daily deficiency was 0·12 in., and from the 25th till the end of the month there was an average excess daily of 0·11 in.

The mean reading of the barometer for the month of April at the height of 159 feet above the sea was 29·602 in., being 0·152 in. below the average of 41 years, and 0·17 in. below that of 1881; and 0·099 in. below that of 1880.

The mean reading of the barometer in May was 29·875 in. being 0·086 in. above the average in 41 years, and 0·054 in. below that of 1881, and 0·035 in. below that of 1880.

The mean reading of the barometer in June was 29·735 in. being 0·071 in. below the average of 41 years, 0·071 in. below that of 1881, and 0·002 in. above that of 1880.

The atmospheric pressure in April was 0·241 in. below that in March, that in May was 0·273 in. above that in April, and that in June was 0·140 in. below that in May.

(From the 41 years observations the mean pressure in April is 0·008 in. greater than in March; in May is 0·035 in. greater in April and in June is 0·017 in. greater than in May).

From March to April there was a decrease of atmospheric pressure, at stations south of latitude 51°, of 0·30 in.; between the latitudes of 51° and 52° of 0·26 in.; between 52° and 53° of 0·20 in.; between 53° and 54° of 0·18 in., and north of latitude 54 of 0·09 in.

From April to May there was an increase everywhere and of nearly the same amount, viz., 0·28 in. From May to June there was a decrease 0·09 in. at stations south of 51° gradually increasing, going northward to 0·20 in. at stations north of 54.

Thunderstorm occurred in April on the 2nd at Guernsey; on the 13th at Liverpool; on the 24th at Royston, Somerleyton, and Leicester; on the 28th at Bolton and Bradford; and on the 30th at Llandudno and Stonyhurst. In May on the 1st at Bolton, Bermerside, Stonyhurst, and Bradford; on the 3rd at Guernsey, Somerleyton, Rugby, Wolverhampton, Bolton, Bermerside, Hull, Stonyhurst, and Bradford; on the 4th at Rugby; on the 7th at Cambridge and Leicester; on the 8th at Wolverhampton; on the 22nd at Barnet, Rugby, Wolverhampton, and Liverpool; on the 23rd at Oxford, Stockton, Cambridge, Leicester, Liverpool, Bolton, and Llandudno; and on the 26th at Halifax, Bradford, and Hull. In June on the 4th and 6th at Stonyhurst; on the 7th and 8th at Cambridge; on the 9th at Osborne and Cambridge; on the 10th at Barnet; on the 12th at Salisbury; on the 15th at Halifax; on the 18th at Osborne and Halifax; on the 23rd at Liverpool and Stonyhurst; on the 24th at Liverpool and Llandudno; on the 25th at Liverpool; on the 26th at Whitchurch, Barnet, Stockton, and Wolverhampton.

Thunder was heard but lightning was not seen in April; on the 2nd at Oxford and Stockton; on the 15th at Salisbury and Blackheath; on the 28th at Guernsey and Hull; and on the 30th at Stockton. In May on the 1st at Wolverhampton; on the 2nd at Halifax; on the 3rd at Salisbury, Strathfield Turgiss, Whitchurch, Oxford, Royston, and Liverpool; on the 7th at Hull and Carlisle; on the 8th at Whitchurch; on the 11th at Llandudno; on the 22nd at Guernsey, Ventnor, Oxford, Cambridge, Bolton, and Halifax; on the 23rd at Whitchurch, Barnet, Llandudno, and Halifax; on the 26th at Bolton; on the 27th at Halifax, Hull, Stonyhurst, and Leeds. In June on the 2nd at Liverpool; on the 3rd at Somerleyton, Stockton, and Liverpool; on the 4th at Barnet, Somerleyton, and Halifax; on 6th at Halifax; on the 9th at Whitchurch, Oxford, Stockton; on the 12th at Barnstaple, Somerleyton, Lowestoft; on the 15th at Stockton and Cambridge; on the 16th at Cambridge; on the 18th at Somerleyton, Stockton, and Silloth; on the 23rd at Llandudno; on the 24th at Halifax, Stonyhurst, and Silloth; on the 25th at Somerleyton, Llandudno, and Stonyhurst; on the 26th at Oxford, Llandudno, Stonyhurst, and Carlisle; on the 27th at Carlisle; on the 28th at Llandudno; on the 29th at Silloth and Carlisle; and on the 30th at Barnstaple, Wolverhampton, and Stonyhurst.

Lightning was seen but thunder was not heard in April, on the 5th at Barnet and Cambridge; in May, on the 3rd at Royston and Cambridge, on the 7th at Barnet, Oxford, Royston, Liverpool, and Halifax, on the 8th at Barnet, and on the 22nd at Osborne; in June, on the 24th at Lowestoft.

Solar halos were seen in April, on the 1st, 16th, and 21st at Oxford, on the 21st at Stonyhurst, on the 25th at Hull. In May on the 2nd at Torquay and Oxford, on the 3rd at Oxford, on the 6th and 9th at Torquay, Strathfield, and Oxford, on the 18th and 21st at Bath. In June on the 12th at Halifax, on the 17th at Oxford, and on the 25th at Liverpool.

Lunar halos were seen on three nights in April, and on three nights in May.

Snow fell in April on the 29th at Liverpool, Bolton and Stonyhurst. In May on the 15th at Cambridge.

Hail fell on April on the 1st at Torquay; on the 2nd at Guernsey; on the 5th at Salisbury; on the 13th at Llandudno; on the 14th at Truro and Royston; on the 15th at Torquay; on the 24th at Whitchurch, Oxford, Royston, Cardington, Stockton, and Bolton; on the 25th at Stonyhurst; on the 26th at Torquay; on the 27th, 28th, 29th at Truro; on the 28th at Truro and Hull; on the 29th at Truro; on the 30th at Torquay, Oxford, Cambridge, and Carlisle. In May on the 1st at Torquay, Halifax, and Stonyhurst; on the 3rd at Stockton, Wolverhampton, and Bolton; on the 8th at Cambridge; on the 22nd at Stockton; on the 23rd at Llandudno; on the 26th at Hull; on the 28th and 30th at Bath. In June on the 4th at Halifax; on the 6th at Llandudno; on the 7th and 9th at Cambridge; on the 10th at Barnet, Bolton, and Halifax; on the 12th at Ventnor, Marlborough, Barnet, Oxford, Stockton, Cambridge, Bolton, and Stonyhurst; on the 14th at Bolton; on the 15th at Cambridge and Halifax; on the 18th at Marlborough and Cambridge; and on the 23rd at Bolton.

MONTHLY METEOROLOGICAL TABLE FOR THE QUARTER ENDING JUNE 30TH, 1882.

The Observations have been reduced to Mean values by Glaisher's Barometrical and Diurnal Range Tables, and the Hygrometrical results have been deduced from the sixth edition of his Hygrometrical Tables.

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1882. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean Of all Highest.	Temperature of Air in Month. Mean Of all Lowest.	Temperature of Air in Month. Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Satn. = 100.	Mean Weight of cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	Wind. Relative Proportion of E.	Wind. Relative Proportion of S.	Wind. Relative Proportion of W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									
GUERNSEY, Adolphus Collenette, Esq., F.M.S.	204	April	29·503	1·124	60·8	37·0	23·8	54·3	44·7	9·6	48·4	45·5	·305	3·4	0·4	90	537	101·5	41·8	1·1	6	7	9	8	4·4	5·9	19	4·32
		May	29·750	0·988	66·3	45·0	21·3	60·3	48·6	11·7	53·3	49·3	·352	4·0	0·6	86	537	113·8	46·0	0·8	4	11	9	7	3·2	4·3	9	2·32
		June	29·690	0·637	68·6	44·8	23·8	62·1	51·5	10·6	55·4	51·7	·385	4·4	0·6	85	533	113·9	48·5	1·0	8	2	8	12	3·1	6·0	22	2·91
TRURO (Cornwall), C. Barham, Esq., M.D., F.M.S.	43	April	29·708	1·263	63·0	30·0	33·0	57·8	42·7	15·1	48·0	44·1	·292	3·4	0·4	88	542	—	—	2·7	6	7	9	8	—	6·5	22	5·98
		May	29·940	1·060	73·0	35·0	38·0	63·3	45·3	18·0	51·7	46·6	·320	3·6	0·7	84	542	—	—	2·6	4	11	9	7	—	5·9	11	1·84
		June	29·868	0·590	70·0	37·0	33·0	63·1	50·4	12·7	53·9	49·2	·349	4·0	0·7	85	537	—	—	2·8	5	3	9	13	—	7·2	18	3·59
PLYMOUTH (Devon), J. Merrifield, Esq., LL.D., F.R.A.S., F.M.S.	69	April	29·699	1·006	62·5	35·0	27·5	56·2	43·3	12·9	47·9	45·1	·301	3·3	0·5	91	542	—	—	1·7	7	7	9	7	—	6·7	23	5·06
		May	29·953	1·095	70·1	38·5	31·6	64·0	47·2	14·9	53·9	47·4	·326	3·7	1·1	79	539	—	—	1·6	7	11	5	8	—	6·0	10	0·85
		June	29·858	0·664	70·5	43·7	26·8	63·5	51·5	12·0	56·1	51·4	·380	4·3	0·7	84	536	—	—	1·7	2	3	7	18	—	8·0	21	3·69
TOTNES (Devon), T. H. Edmonds, Esq.	107	April	29·705	1·148	63·9	29·3	34·6	56·3	40·6	15·7	48·4	42·8	·275	3·2	0·4	82	542	109·9	36·6	2·8	6	5	6	13	—	5·7	22	7·26
		May	29·950	1·104	71·3	32·3	48·0	62·1	43·7	18·4	52·6	45·6	·305	3·4	1·1	79	541	124·9	40·4	2·2	7	11	6	7	—	4·9	11	1·47
		June	29·826	0·673	74·2	38·1	36·1	63·5	48·4	15·1	55·8	46·2	·314	3·5	1·5	71	536	126·2	45·1	3·0	3	3	5	19	—	6·8	24	4·41
TORQUAY, Babbacombe (Devon), Edwin E. Glyde, Esq., F.M.S.	305	April	29·439	1·419	64·3	33·9	30·4	54·5	42·2	12·3	47·4	42·1	·268	3·1	0·6	82	538	109·0	35·4	1·6	6	7	8	9	6·5	6·4	23	6·49
		May	29·710	1·091	66·7	37·5	29·2	60·0	46·6	13·4	52·2	45·5	·305	3·4	1·0	80	537	122·4	39·7	1·3	6	12	5	8	5·3	5·7	11	1·52
		June	29·624	0·724	70·7	42·2	28·5	62·4	49·3	13·1	53·7	50·3	·364	4·1	0·5	88	534	122·3	43·2	1·5	4	5	11	10	6·3	6·9	19	3·56
VENTNOR, (Isle of Wight) (Royal National Hospital for Consumption), Hartley Sagar, Esq.	150	April	29·673	1·036	62·8	38·2	24·6	55·8	44·3	11·5	47·9	42·3	·270	3·1	1·0	75	539	—	—	1·4	5	8	7	10	5·5	5·5	17	3·14
		May	29·931	1·110	69·1	40·6	28·5	61·2	48·3	12·9	53·0	48·6	·342	3·8	0·7	85	540	—	—	1·2	4	12	6	9	6·1	6·0	8	1·08
		June	29·847	0·742	68·6	41·4	27·2	64·0	51·5	12·5	55·7	50·9	·378	4·2	0·9	84	535	—	—	1·2	3	3	6	18	5·1	5·1	18	2·29
EASTBOURNE (Sussex), Miss W. L. Hall.	12	April	—	—	61·4	35·3	26·1	57·4	40·7	16·7	48·3	43·7	·284	2·9	0·6	85	—	109·9	35·7	0·4	3	10	7	11	2·7	—	15	3·03
		May	—	—	73·4	37·8	35·6	64·1	45·7	18·4	54·1	49·7	·355	4·1	0·6	84	—	115·3	38·1	0·4	3	8	10	10	3·2	—	8	1·16
		June	—	—	71·4	42·6	28·8	66·5	50·9	15·6	58·0	51·9	·388	4·0	1·1	80	—	120·5	44·6	0·3	5	3	10	12	3·6	—	19	2·68
OSBORNE (Isle of Wight), J. R. Mann, Esq.	172	April	29·587	1·246	65·0	34·9	30·1	58·5	42·1	16·4	48·6	45·8	·310	3·5	0·4	91	539	113·7	39·2	0·2	5	8	10	7	—	4·8	16	3·30
		May	29·854	1·120	72·5	39·0	33·5	65·9	46·1	19·8	54·7	49·8	·358	4·1	0·8	84	537	123·9	42·7	0·2	6	8	11	6	—	4·0	6	0·84
		June	29·740	0·762	74·1	42·1	32·0	67·2	50·4	16·8	56·6	52·8	·400	4·5	0·6	87	533	118·9	48·2	0·1	3	3	11	13	—	6·8	17	3·35
SOUTHBOURNE ON SEA (Hants), T. A. Compton, Esq., M.D., B.A., F.M.S.	95	April	29·668	1·058	62·2	34·9	27·3	55·3	42·3	13·0	48·0	40·6	·253	2·9	0·9	76	541	—	—	3·3	6	9	9	6	—	5·1	18	3·73
		May	29·934	1·096	68·8	36·3	32·5	59·9	46·1	13·8	52·0	43·3	·281	3·2	1·2	74	542	—	—	2·5	7	11	8	5	—	4·4	10	1·47
		June	29·853	0·780	70·4	39·5	30·9	62·4	50·0	12·4	55·2	48·5	·344	3·9	1·0	79	536	—	—	1·5	6	3	7	14	—	6·4	16	3·16
SALISBURY (Wilton House), Wilts, Thomas Challis, Esq.	186	April	29·563	1·212	67·0	26·0	41·0	59·5	37·5	22·0	47·8	41·3	·260	3·0	0·8	79	540	104·0	33·8	1·2	4	7	10	9	—	5·6	17	4·53
		May	29·833	1·068	75·0	31·0	44·0	67·5	41·1	26·4	53·2	46·8	·320	3·6	1·0	81	538	117·6	37·0	1·2	4	10	8	9	—	4·9	11	2·21
		June	29·717	0·792	74·0	33·0	41·0	67·2	45·6	21·6	55·3	48·1	·337	3·8	1·1	77	534	115·2	43·5	1·4	8	2	9	11	—	6·2	21	3·90
BRIGHTON,	206	April	29·569	1·160	61·4	35·0	26·4	56·4	42·3	14·1	48·5	40·6	·253	2·9	1·0	74	540	98·3	37·2	1·3	6	6	8	10	—	6·2	19	3·24
		May	29·830	1·095	72·0	39·6	32·4	62·8	47·2	15·6	53·9	45·0	·304	3·4	1·1	74	538	110·1	41·3	1·1	5	8	8	10	—	5·4	12	1·31
		June	29·710	0·783	73·3	41·0	32·3	66·7	50·8	15·9	57·4	50·3	·329	4·1	1·2	79	531	111·1	44·8	1·0	4	1	11	14	—	7·9	19	2·27
BARNSTAPLE (Devon), William Knill, Esq.	43	April	29·689	1·330	65·0	37·0	28·0	58·0	45·6	12·4	50·6	46·3	·315	3·6	0·5	86	539	—	—	1·3	5	6	10	9	—	4·2	23	4·96
		May	29·983	1·120	72·0	39·0	33·0	64·9	51·1	13·8	56·5	51·0	·374	4·2	0·9	82	537	—	—	1·2	5	7	13	6	—	2·7	9	1·92
		June	29·895	0·690	73·5	41·0	32·5	65·9	53·7	12·2	57·9	53·5	·412	4·6	0·9	86	534	—	—	1·7	2	3	9	16	—	5·1	23	3·23

NAMES of STATIONS and OBSERVERS.	Height of Station above Sea Level.	Year 1882. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean Of all Highest.	Temperature of Air in Month. Mean Of all Lowest.	Temperature of Air in Month. Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a Cubic foot of Air. Mean.	Vapour. In a Cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	Wind. Relative Proportion of E.	Wind. Relative Proportion of S.	Wind. Relative Proportion of W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
CATERHAM (Surrey), Metropolitan Asylum, G. STANLEY ELLIOT, Esq., M.D.	669	April	—	—	60·0	34·0	26·0	53·4	42·9	10·5	46·7	43·1	·279	3·2	0·5	88	537	—	—	1·1	5	6	10	9	—	4·4	13	3·15
		May	—	—	68·0	37·0	21·0	60·4	50·6	9·8	53·1	48·1	·336	3·8	0·7	83	531	—	—	1·1	5	7	13	6	—	4·8	9	1·31
		June	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
STRATHFIELD TURGISS (Hants), REV. C. H. GRIFFITH, M.A., F.M.S.	197	April	29·587	1·347	64·5	30·2	34·3	57·6	38·8	18·8	48·1	42·2	·269	3·1	0·7	80	540	104·2	31·7	1·7	4	7	9	10	1·9	5·7	17	3·40
		May	29·852	1·101	71·4	33·1	38·3	65·5	43·4	22·1	53·9	46·2	·311	3·5	1·2	75	538	110·8	36·7	1·2	6	6	9	10	2·2	4·3	8	1·42
		June	29·713	0·866	73·2	36·6	36·6	65·6	46·7	18·9	55·3	50·0	·362	4·1	1·0	81	534	118·3	40·7	1·2	4	4	6	16	2·5	7·4	15	2·00
BATH (Somerset), St. Gregory's College, Downside, REV. T. J. ALMOND, O.S.B., F.M.S.	596	April	29·100	1·275	62·2	31·0	31·2	54·0	39·7	14·3	45·8	40·6	·255	2·9	0·4	83	533	103·0	36·8	1·6	8	6	7	10	—	6·5	19	5·37
		May	29·383	1·095	66·0	34·5	21·5	60·5	43·9	16·6	50·9	45·2	·302	3·4	0·8	82	533	117·3	41·1	1·2	7	6	7	11	—	5·5	12	2·36
		June																										
MARLBOROUGH (Wilts), REV. THOMAS A. PRESTON, M.A., F.M.S.	456	April	29·259	1·390	61·4	30·5	30·9	55·1	39·3	15·8	46·3	40·4	·252	3·0	0·7	81	536	104·2	33·7	0·9	4	11	10	5	—	6·1	19	5·00
		May	29·548	1·086	68·1	32·7	35·4	61·9	43·4	18·5	51·7	44·5	·293	3·3	1·0	77	535	116·9	35·7	0·6	5	8	8	10	—	5·5	12	2·39
		June	29·402	0·824	70·2	37·1	33·1	62·4	47·3	15·1	53·5	48·4	·341	3·9	0·8	82	530	115·8	42·6	0·6	3	3	6	18	—	7·7	21	5·84
BLACKHEATH (Kent), JAMES GLAISHER, Esq., F.R.S.	150	April	29·607	1·492	65·0	34·0	31·0	56·6	41·0	15·6	47·4	40·2	·249	2·9	0·9	77	541	100·2	36·4	0·9	4	7	9	10	—	6·0	11	2·67
		May	29·882	1·133	75·0	38·0	37·0	65·4	46·2	19·2	54·3	45·6	·305	3·5	1·3	72	538	126·4	40·8	1·1	7	7	10	7	—	4·6	12	1·53
		June	29·744	0·852	71·0	42·5	31·5	64·9	49·9	15·0	55·7	48·7	·347	3·8	1·1	78	534	111·9	44·6	1·2	3	3	9	15	—	5·9	19	2·81
ROYAL OBSERVATORY, Greenwich, W. H. M. CHRISTIE, M.A., F.R.S., Astronomer Royal.	159	April	29·602	1·501	65·7	31·8	33·9	57·6	39·8	17·8	47·9	42·5	·272	3·1	0·7	82	540	112·7	32·0	0·7	—	—	—	—	7·5	6·4	13	2·40
		May	29·875	1·158	76·5	34·5	42·0	66·2	44·2	22·0	54·5	46·6	·318	3·6	1·2	75	538	132·5	36·2	0·3	—	—	—	—	5·4	5·5	11	1·37
		June	29·735	0·900	74·1	40·9	33·2	66·3	48·9	17·4	56·5	50·4	·366	4·1	1·0	80	533	119·4	44·0	0·4	—	—	—	—	6·5	8·1	19	2·36
WHITCHURCH RECTORY (Oxon), (near Reading). REV. J. SLATTER, M.A., F.M.S.	150	April	29·630	1·351	64·8	30·0	34·8	58·3	39·0	19·3	48·2	41·7	·263	3·0	0·9	79	540	—	—	1·9	5	9	8	8	—	6·0	17	4·12
		May	29·961	1·030	74·0	33·8	40·2	65·7	42·7	23·0	52·6	45·8	·286	3·2	1·3	78	541	—	—	1·5	5	8	8	10	—	4·9	9	1·41
		June	29·754	0·872	74·4	36·8	37·6	66·9	46·2	20·7	56·0	49·6	·337	4·0	1·0	78	534	—	—	1·8	5	3	10	12	—	7·8	18	2·67
CAMDEN SQUARE (London), G. J. SYMONS, Esq., F.R.S., F.M.S.	123	April	29·620	1·298	65·5	32·6	32·9	58·2	40·8	17·4	48·3	42·2	·270	3·1	0·8	81	540	99·6	35·9	—	7	7	9	7	—	6·4	14	2·83
		May	29·918	1·076	74·2	37·3	36·9	66·9	45·5	21·4	54·8	44·8	·297	3·1	1·5	69	539	114·0	46·5	—	11	9	6	5	—	1·8	11	1·20
		June	29·773	0·885	74·3	41·5	32·8	66·8	49·1	17·4	56·5	47·6	·330	3·7	1·4	71	534	111·1	46·5	—	7	3	8	12	—	6·8	18	2·30
BARNET (Gas Works), T. H. MARTIN, Esq., C.E.	212	April	29·573	1·322	61·1	27·9	36·2	57·0	37·8	19·2	46·4	40·8	·256	3·0	0·6	82	541	113·7	32·2	1·8	6	9	8	7	—	6·2	14	3·30
		May	29·843	1·077	71·8	31·5	40·3	65·8	41·7	22·1	52·1	44·8	·298	3·4	1·0	77	540	132·6	35·7	1·4	5	9	6	11	—	5·4	14	1·19
		June	29·703	0·903	72·0	37·1	34·9	65·0	46·8	18·2	54·6	48·7	·343	3·9	0·9	80	534	126·1	40·6	1·6	9	4	6	11	—	8·2	19	2·38
OXFORD (The Observatory), E. J. STONE, Esq., M.A., F.R.S.	210	April	29·540	1·332	61·9	30·9	31·0	56·6	41·2	15·4	45·1	42·3	·270	3·1	0·7	81	539	106·9	37·3	2·9	5	9	9	7	2·2	6·3	23	3·64
		May	29·822	1·264	68·4	35·8	32·6	62·9	45·0	17·2	53·9	45·4	·301	3·4	1·3	78	537	116·2	40·6	2·5	8	9	8	6	2·2	4·9	9	2·15
		June	29·675	0·914	71·0	41·1	29·9	63·6	49·2	14·4	56·2	49·4	·355	4·0	1·1	78	532	114·8	45·6	4·0	4	3	10	13	2·2	7·6	18	3·30
GLOUCESTER COUNTY ASYLUM, E. TOLLER, Esq., M.R.C.S., F.M.S.	100	April	29·659	1·558	67·5	28·0	39·5	58·9	39·7	19·2	47·8	42·5	·272	3·1	0·6	83	539	103·5	26·7	1·5	5	5	6	14	2·3	5·7	14	2·55
		May	29·920	1·134	74·0	32·0	42·0	68·4	42·2	26·2	53·4	48·4	·340	3·8	0·7	83	540	117·3	39·8	1·4	7	9	4	11	3·0	5·3	11	2·15
		June	29·795	0·914	77·0	37·0	40·0	67·4	47·4	20·0	56·2	49·2	·354	4·0	1·1	78	535	121·6	43·9	1·4	5	11	7	7	1·7	4·4	15	2·20
ROYSTON (Hertfordshire), HALE WORTHAM, Esq., F.R.A.S., F.M.S.	269	April	29·498	1·402	66·8	28·9	37·9	58·3	38·6	19·7	46·4	41·7	·264	3·0	0·6	84	540	—	—	—	8	9	8	5	—	5·8	15	2·91
		May	29·790	1·198	73·5	32·0	41·5	65·3	42·6	22·7	52·5	46·2	·314	3·5	0·9	79	530	—	—	—	9	8	7	7	—	5·6	9	1·04
		June	29·628	0·931	75·1	40·2	34·9	67·2	47·5	19·7	54·8	50·9	·372	4·1	0·7	87	533	—	—	—	3	5	8	14	—	7·2	17	2·28
BEDFORD, Cardington, MR. J. MCLAREN, Assistant to S. WHITBREAD, Esq., M.P.	105	April	29·627	1·354	66·0	29·6	36·4	57·6	39·2	18·4	47·5	42·2	·269	3·1	0·7	83	541	87·3	33·3	1·7	5	8	11	6	—	6·0	15	3·10
		May	29·893	1·126	75·6	33·0	42·6	64·8	42·9	21·9	52·7	44·3	·292	3·3	1·3	73	540	105·0	36·1	1·6	11	8	7	5	—	5·5	10	1·50
		June	—	—	74·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	16	2·60
CAMBRIDGE (Trinity College), J. W. L. GLAISHER, Esq., M.A., F.R.S.	40	April	29·708	1·392	70·1	30·0	40·1	59·7	39·3	20·4	47·8	41·3	·260	3·0	0·8	79	542	122·6	32·1	1·4	9	7	8	6	—	5·6	20	2·87
		May	29·984	1·142	76·0	32·0	44·0	67·3	42·6	24·7	53·6	46·9	·320	3·6	1·0	77	541	140·9	34·2	1·1	10	10	6	5	—	4·7	12	1·35
		June	29·824	0·960	77·0	37·6	39·4	69·0	48·0	21·0	56·1	50·7	·372	4·2	0·8	83	535	140·1	42·1	1·2	6	9	13	2	—	7·3	18	2·35

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1881. Months.	Pressure of Atmosphere in Month. Mean.	Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean Of all Highest.	Mean Of all Lowest.	Mean Daily Range.	Mean Temperature. Air.	Dew Point.	Vapour. Elastic Force.	In a cubic foot of Air. Mean.	Short of Saturation.	Mean Degree of Humidity. Sat^n. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer Maximum in Rays of Sun.	Minimum on Grass.	Wind. Estimated Strength.	Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
RUGBY (Warwickshire), Stockton, The Rectory, REV. W. TUCKWELL.	289	April	29·334	1·324	66·5	23·5	43·0	57·3	37·8	19·5	46·1	43·8	·284	3·3	0·8	84	537	—	—	0·7	6	10	8	6	6·6	6·2	20	3·17
		May	29·611	1·110	74·0	29·0	45·0	64·7	40·7	24·0	51·8	46·6	·324	3·7	0·6	85	536	—	—	0·5	11	9	8	5	7·1	4·9	11	1·53
		June	29·457	0·996	76·6	39·5	37·1	66·4	44·8	21·6	54·3	49·9	·360	4·1	0·7	84	530	—	—	0·6	6	2	10	12	8·3	8·5	19	4·29
LOWESTOFT (Suffolk), S. H. MILLER, ESQ., F.R.A.S., F.M.S.	89	April	29·665	1·462	61·1	34·7	26·4	52·1	41·4	10·7	46·1	40·8	·256	3·0	0·7	84	543	99·2	39·1	0·7	3	10	7	10	—	6·3	13	2·48
		May	29·954	0·960	68·0	35·9	32·1	57·4	49·1	8·3	52·0	46·3	·315	3·6	0·8	81	542	115·1	43·1	4·5	5	11	7	7	—	5·7	9	1·96
		June	29·766	0·992	69·7	40·0	29·7	62·0	48·9	13·1	54·5	47·4	·326	3·8	1·1	76	536	118·1	46·9	0·7	4	3	8	15	—	7·0	10	3·00
SOMERLEYTON (Suffolk), The Rectory, REV. C. J. STEWARD, F.M.S.	50	April	29·754	1·218	62·4	32·2	30·2	53·8	40·8	13·0	45·6	41·9	·268	3·0	0·5	87	515	—	—	1·1	5	7	10	8	6·8	5·7	18	3·02
		May	29·978	1·100	69·8	35·2	34·6	59·7	45·2	14·5	50·8	45·0	·300	3·4	0·8	81	544	—	—	1·0	8	11	6	6	7·2	4·5	9	1·70
		June	29·817	0·984	70·2	37·0	33·2	62·7	49·2	13·5	55·0	50·5	·367	3·7	0·8	85	556	—	—	1·1	6	3	9	12	6·9	7·3	11	2·72
WOLVERHAMPTON (Staffordshire), Wrottesley, E. SIMPSON, ESQ.	500	April	29·227	1·310	61·7	28·1	33·6	53·5	37·7	15·8	41·4	39·4	·242	2·8	0·6	83	537	—	—	—	4	11	9	6	—	7·3	14	3·16
		May	29·514	1·146	69·5	34·0	35·5	62·2	41·7	20·5	50·5	42·3	·271	3·2	1·0	74	536	—	—	—	6	13	8	4	—	3·8	13	2·96
		June	29·340	0·948	72·1	41·0	31·1	62·7	46·4	16·3	53·1	46·5	·316	3·2	0·9	78	531	—	—	—	6	5	8	11	—	4·3	19	5·49
LEICESTER (Town Museum), W. J. HARRISON, ESQ., F.G.S.	238	April	29·480	1·418	65·1	29·0	36·1	55·7	40·1	15·6	47·0	39·8	·245	2·8	1·1	77	539	103·2	31·2	1·0	6	7	9	8	—	5·8	19	2·09
		May	29·775	1·040	72·6	35·0	37·6	64·0	44·1	19·9	53·0	43·0	·277	3·1	1·4	69	538	117·7	—	0·6	8	10	7	6	—	5·6	15	2·53
		June	29·609	0·988	73·2	41·0	32·2	64·6	48·1	16·5	55·4	47·6	·343	3·9	1·1	78	532	118·9	—	0·7	6	2	10	12	—	7·3	21	1·11
NOTTINGHAM (Notts), M. O. TARBOTTON, ESQ., C.E., F.G.S., F.M.S.	183	April	29·547	1·332	66·6	26·2	40·4	56·4	39·1	17·3	46·5	40·7	·255	3·0	0·9	82	541	95·7	37·6	0·3	6	9	8	7	2·4	6·5	20	2·70
		May	29·829	1·144	78·2	34·3	43·9	65·7	42·5	23·2	52·6	41·6	·295	3·1	1·2	75	539	113·4	39·4	0·3	9	12	4	6	2·5	4·1	15	2·41
		June	29·650	1·030	75·7	39·1	36·6	67·2	46·9	20·3	55·4	49·7	·358	4·0	0·9	82	532	106·6	41·9	0·3	4	5	7	14	1·7	7·6	18	3·99
HOLKHAM (Norfolk), JOHN DAVIDSON, ESQ., Assistant to the Earl of Leicester.	30	April	29·740	1·284	64·5	25·7	38·8	53·8	36·3	17·5	44·6	41·3	·260	2·9	0·4	89	546	98·0	31·2	2·0	8	8	12	2	—	6·4	—	—
		May	29·975	1·190	71·0	27·2	43·8	60·2	39·8	20·4	49·9	45·4	·304	3·5	0·7	86	545	123·3	32·8	1·6	18	4	7	2	—	5·2	8	1·15
		June	29·802	1·000	72·2	32·5	39·7	63·9	45·2	18·7	53·3	49·5	·354	4·0	0·6	85	538	123·1	37·7	1·9	9	1	14	6	—	7·0	21	3·90
LLANDUDNO (Carnarvonshire), JAMES NICOL, ESQ., M.D.	197	April	29·639	1·470	61·8	33·5	28·3	52·2	41·3	10·9	46·4	40·9	·257	3·0	0·7	83	543	—	—	1·0	1	12	7	10	—	6·7	19	3·18
		May	29·916	1·270	65·5	33·8	31·7	58·7	45·0	13·7	51·6	44·0	·289	3·2	1·1	86	542	—	—	1·0	2	12	7	10	—	5·3	10	1·63
		June	29·768	0·980	68·5	43·2	25·3	60·8	49·2	11·6	54·0	47·9	·341	3·8	0·6	79	537	—	—	1·0	5	3	6	16	—	7·5	20	2·99
LIVERPOOL, The Observatory, JOHN HARTNUP, ESQ., F.R.A.S.	197	April	29·520	1·378	60·4	26·1	34·3	53·6	41·1	12·5	45·9	41·2	·260	2·9	0·7	85	541	—	—	—	5	8	7	10	—	6·4	18	3·12
		May	29·803	1·237	71·3	37·5	33·8	59·9	45·7	14·2	51·9	46·9	·322	3·6	0·8	84	539	—	—	—	8	9	8	14	—	5·0	13	1·15
		June	29·644	1·020	67·1	43·9	23·2	60·3	49·5	10·8	53·6	47·5	·328	3·7	0·9	79	534	—	—	—	4	3	10	13	—	7·2	21	4·25
BOLTON, Sharples (Lancashire), REV. T. MACKERETH, F.R.A.S., F.M.S.	500	April	29·201	1·416	61·1	29·1	32·0	52·5	38·1	14·4	44·5	38·4	·233	2·7	0·7	78	536	64·3	31·2	2·4	4	11	9	6	8·8	7·0	20	6·03
		May	29·487	1·180	68·7	35·1	33·6	60·2	41·5	18·7	50·2	41·0	·257	2·9	1·2	71	531	77·7	34·3	1·2	6	10	9	6	2·5	5·2	14	2·99
		June	29·315	1·024	71·3	39·0	32·3	60·8	46·1	14·7	52·2	46·6	·316	3·6	0·8	81	530	75·7	39·7	1·7	5	5	8	12	4·2	7·7	23	8·13
HALIFAX, Bermerside Observatory (Yorkshire), E. J. CROSSLEY, ESQ., F.R.A.S.	530	April	29·205	1·386	65·2	28·5	36·7	52·2	37·4	14·8	43·5	38·3	·231	2·7	0·6	81	538	86·0	35·7	0·8	6	10	6	8	—	7·4	20	5·27
		May	29·512	1·200	69·4	29·7	39·7	62·3	40·2	22·1	50·8	41·4	·231	3·0	1·2	71	533	106·9	38·1	0·8	6	10	8	7	—	5·1	14	1·68
		June	29·308	1·134	74·0	36·0	38·0	64·2	45·8	18·4	51·9	49·3	·352	4·0	0·4	91	530	106·9	43·6	0·7	3	3	10	14	—	7·3	20	4·89
HULL (Yorkshire), The People's Park, MR. E. PEAK.	12	April	29·760	1·484	65·0	28·0	37·0	52·7	39·0	13·7	45·7	39·2	·241	2·7	1·0	79	546	80·1	36·0	1·8	8	6	10	6	0·8	6·5	18	4·03
		May	30·039	1·090	70·0	33·0	37·0	60·4	42·1	18·3	51·3	42·1	·269	3·1	1·0	71	544	[87·7	39·3	1·3	4	11	6	10	2·1	5·0	12	1·66
		June	29·833	0·972	76·0	40·0	36·0	65·0	46·3	18·7	54·9	48·6	·335	3·9	1·0	79	536	98·1	45·4	1·3	3	5	8	14	—	5·5	21	3·64
STONYHURST (Lancashire), REV. S. J. PERRY, F.R.S., F.M.S., F.R.A.S.	363	April	29·338	1·443	60·0	30·5	29·5	54·5	41·0	13·5	45·7	30·2	·239	2·7	0·8	79	538	100·3	36·3	—	4	11	4	11	—	7·9	14	5·66
		May	29·638	1·210	73·0	37·0	36·0	63·1	45·9	17·2	51·9	43·9	·288	3·3	1·1	74	537	124·4	39·4	—	4	11	6	10	—	5·0	11	2·76
		June	29·472	1·034	75·0	45·0	30·0	63·8	51·1	12·7	54·3	50·7	·370	4·2	0·7	88	530	128·2	46·5	—	4	3	4	19	—	8·0	20	6·07
BRADFORD (Yorkshire), J. MCLANDSBOROUGH, ESQ., C.E., F.G.S.	366	April	29·344	1·462	62·3	32·0	30·3	52·6	39·9	12·7	44·8	39·2	·239	2·8	0·6	81	539	70·2	—	1·1	2	8	5	15	—	7·0	20	4·41
		May	29·607	1·205	69·7	36·0	33·7	61·3	44·4	16·9	51·3	41·3	·261	2·9	1·3	69	537	85·7	—	0·9	5	8	9	9	—	4·9	11	0·92
		June	29·441	1·014	74·4	41·0	33·4	63·2	48·8	14·4	54·5	45·5	·304	3·4	1·4	71	530	85·4	—	0·9	4	4	6	16	—	6·0	26	3·92

NAMES of STATIONS and OBSERVERS.	Height of S[…] above Sea Le[…]	Months.	Mean.	Range.	Highest.	Lowest.	Range.	Of all Highest.	Of all Lowest.	Daily Range.	Air.	Dew Point.	Elastic Force.	[…] foot of Air. Mean.	Short of Saturation.	Mean Degree of […]dity. Satn.=[…]	Mean Weight [of a] cubic foot of [Air].	Maximum in Rays of Sun.	Minimum on Grass.	Estimated Strength.	[Relative] Proportion of N.	E.	S.	W.	Mean Amoun[t of] Ozone.	Mean Amoun[t of] Cloud.	Number of Day[s] it fell.	Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
LEEDS (Yorkshire), The Philosophical Hall, HENRY CROWTHER, Esq.	137	April	29·571	1·502	66·0	32·0	34·0	51·5	40·5	11·0	46·5	42·0	·2?8	3·1	0·6	85	541	68·0	—	1·2	5	9	7	9	—	6·7	16	3·21
		May	29·862	1·291	72·0	39·0	33·0	63·9	44·2	19·7	53·4	43·4	·282	3·2	1·2	69	538	73·0	—	1·2	5	8	6	12	—	4·4	11	1·20
		June	29·692	1·078	74·0	41·0	33·0	65·5	48·9	16·6	55·7	49·9	·361	4·0	0·9	81	533	80·0	—	1·4	5	5	6	14	—	6·6	16	3·33
LANCASTER (Southfields), WILLIAM ROPER, Esq.	114	April	29·636	1·414	62·0	30·0	32·0	51·8	39·3	12·5	41·8	38·1	·230	2·6	0·8	77	541	—	—	—	—	—	—	—	—	—	14	4·06
		May	29·890	1·152	73·0	33·0	40·0	60·2	42·0	18·2	50·8	41·8	·255	3·0	1·2	72	542	—	—	—	—	—	—	—	—	—	14	2·11
		June	29·727	0·798	69·0	40·0	29·0	61·4	47·5	13·9	53·3	46·5	·317	3·3	1·0	77	537	—	—	—	—	—	—	—	—	—	18	4·49
SILLOTH (Cumberland), "The Rectory," REV. F. REDFORD, M.A., F.R.A.S., F.M.S.	28	April	29·706	1·317	59·3	26·8	32·5	52·1	38·6	13·5	43·9	38·9	·238	2·7	0·6	83	547	98·2	35·0	1·7	4	16	3	7	7·1	5·5	13	2·92
		May	29·980	1·256	70·0	33·0	37·0	61·1	42·0	19·1	50·3	41·7	·264	3·0	1·2	75	541	118·6	58·1	1·3	3	12	7	8	6·3	3·4	9	1·89
		June	29·7[illegible]	1·165	73·3	37·0	36·3	64·3	46·9	17·4	54·8	49·0	·345	3·9	0·8	85	537	119·1	44·3	1·3	5	5	6	14	6·2	5·6	18	2·42
CARLISLE, Spital (Cumberland), ISAAC CARTMELL, Esq., F.M.S.	111	April	29·633	1·520	60·0	23·7	36·3	53·8	36·6	17·2	41·3	38·5	·233	2·7	0·7	79	544	88·1	29·4	1·2	2	15	6	7	3·5	6·7	24	3·12
		May	29·886	1·274	75·7	29·2	46·5	62·5	40·7	21·8	50·8	41·3	·262	3·3	0·9	83	542	104·0	31·3	0·8	5	17	2	7	3·6	6·2	9	1·18
		June	29·677	1·270	73·5	35·3	38·2	65·5	45·8	19·7	54·3	48·7	·341	4·0	0·8	81	534	108·6	32·5	0·8	3	8	4	15	4·3	7·4	16	2·65

Second Rain-gauges are placed—

			April.		May.		June.		Total in Quarter.
At Eastbourne, at the height of	160 feet *above the sea*;	the amount collected was	3·50 inches.	-	1·15 inches.	-	2·51 inches.	-	7·16 inches.
" Beachy Head, "	515 "	"	2·21 "	-	1·06 "	-	2·84 "	-	5·61 "
" " "	495 " "	"	2·53 "	-	1·24 "	-	2·25 "	-	6·02 "
" Oxford, "	22 " *ground*	"	3·60 "	-	2·1 "	-	3·20 "	-	8·95 "
" Cardington, "	36 " "	"	2·95 "	-	1·36 "	-	2·71 "	-	7·02 "
" Nottingham, "	39 " "	"	2·47 "	-	2·19 "	-	3·55 "	-	8·21 "
" Holkham, "	4 " "	"	— "	-	1·22 "	-	3·88 "	-	— "

16

A N D,

NAMES OF STATIONS.	Mean Pressure of dry
Guernsey - - -	29
Truro - - -	29
Plymouth - - -	29
Totnes - - -	29
Torquay - - -	29
Ventnor - - -	29
Eastbourne - -	29
Osborne - - -	29
Southbourne - -	29
Salisbury - - -	29
Barnstaple - - -	29
Strathfield Turgiss -	29
Marlborough - -	29
Whitchurch - -	29
Blackheath - - -	29
Royal Observatory -	29
Camden Square -	29
Barnet - - -	29
Oxford - - -	29
Gloucester - -	29
Royston - - -	29
Bedford - - -	29
Cambridge - -	29
Rugby - - -	29
Lowestoft - - -	29
Somerleyton - -	29
Wolverhampton - -	29
Leicester - - -	29
Nottingham - -	29
Holkham - - -	29
Llandudno - -	29
Liverpool - - -	29
Bolton - - -	29
Halifax - - -	29
Hull - - -	29
Stonyhurst - -	29
Bradford - - -	29
Leeds - - -	29
Lancaster - - -	29
Silloth - - -	29
Carlisle - - -	29

The highest temperatu[re]
The lowest temperatur[e]
The greatest daily ran[ge]
The least daily range
The greatest number and Bradford, 54.
The least number of d[ays] and Somerleyton, 4
The heaviest falls of
The least falls of rain

PARALLELS OF LATITUDE, &c.	
Guernsey - - -	
Between the latitudes 50° and 51°	
51° and 52°	
52° and 53°	
53° and 54°	
54° and 55°	
Mean for the Quarter, 50° to 55° — Year 18[…]	
" 18[…]	
" 188	
" 18[…]	

[…]12.

[…]R 30TH, 1882.

[…]th of July was
[…]le 52°, did not
[…]ountry; it was
[ex]ceeded 90° on
[g]enerally below
[…]th of England,
[w]as mostly from
[…] wind from the
[…]d many fields
[sh]owery from the
[…], not reaching
[…]ew in number.
[…] was above its
[…]w during the
[…]ately fine, but
[…]h was less than
[m]onth was lower
[…]ic pressure was
[th]an the average,
[…]r more humid
[…]causing harvest
[…]the end of this
[…]as summerlike
[a]verage till the
[…]h were slightly
[d]ays was 2°·8;
[…]or 3 days cold,
[…] was cold, the
[…] average daily
[…] cold; on the
[…] those 28 days
[…]°·8 below the
[t]he year 1881,
[…]·9 below the
[…], but 3°·2 and
[…]2°·8 below the
Qu[…] than in 1881,
[…] was 52°·9.
[…] the average of
[…]w the average
[…]er it was 64°·0.
[…]0°·7 below its
[…]as 46°·6, being
[t]hroughout the
[…] and in August
[…]st it was 0°·8
[…]ne to July is
[…] September is
[…]8 of tempera-
[…]ast at stations
[…]c.

Air reduced to the level of the Sea.	Highest Reading of the Thermometer.	Lowest Reading of the Thermometer.	Range of Temperature in the Quarter.	Mean of all Highest.	Mean of all Lowest.	Mean Monthly Range of Temperature.	Mean Daily Range of Temperature.	Mean Temperature of the Air.	Mean Temperature of the Dew Point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Mean Reading of Maximum in Rays of Sun.	Mean Reading of Minimum on Grass.	Wind. Mean Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days on which it fell.	Rain. Amount collected.
in.	°	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
[illegible]	68·6	37·0	31·6	58·9	48·5	23·0	10·6	52·4	48·8	·347	3·9	0·5	88	536	109·7	45·4	1·0	6	7	9	9	3·6	5·4	50	7·55
[illegible]	75·0	[illegible]	43·0	61·4	46·1	41·7	15·3	51·2	46·7	·32	3·7	0·6	84	540	—	—	2·7	3	7	9	9	—	6·1	51	11·41
[illegible]	70·5	35·0	35·5	59·6	47·2	28·0	13·[illegible]	52·[illegible]	48·0	·33	3·8	0·8	85	539	—	—	1·7	5	7	7	11	—	6·[illegible]	54	10·26
[illegible]	74·2	29·3	44·9	60·7	41·2	30·6	16·1	52·3	44·9	·298	3·4	1·0	77	540	120·3	37·4	2·7	5	6	6	13	—	5·[illegible]	57	13·16
[illegible]	70·7	37·2	33·5	58·9	46·1	23·4	12·9	51·1	46·0	·31	3·5	0·7	83	53[illegible]	117·9	39·4	1·7	5	5	8	9	6·1	6·[illegible]	53	11·37
[illegible]	69·1	38·2	30·9	60·[illegible]	48·0	26·[illegible]	12·5	52·2	47·3	·33	3·7	0·[illegible]	81	538	—	—	1·[illegible]	4	5	6	12	5·[illegible]	5·4	43	6·[illegible]
—	75·4	37·8	38·1	62·7	45·8	30·[illegible]	16·9	53·[illegible]	48·4	[illegible]	3·7	0·[illegible]	8[illegible]	—	115·2	39·[illegible]	0·7	4	7	9	11	3·[illegible]	—	42	6·[illegible]
[illegible]	74·1	41·9	32·2	[illegible]	46·2	31·9	17·[illegible]	[illegible]	49·5	·35	4·0	0·[illegible]	87	53[illegible]	118·8	43·4	0·[illegible]	5	6	11	9	—	5·[illegible]	39	7·[illegible]
[illegible]	70·4	34·9	[illegible]	[illegible]	40·1	30·[illegible]	15·1	51·7	44·1	·29	3·3	1·0	76	540	—	—	2·4	6	8	8	8	—	5·[illegible]	44	6·[illegible]
[illegible]	75·[illegible]	33·0	40·0	[illegible]	41·4	42·0	[illegible]	52·1	45·1	·30	3·5	1·0	79	53[illegible]	112·[illegible]	38·1	1·[illegible]	3	6	9	10	—	5·[illegible]	49	10·[illegible]
[illegible]	7[illegible]	[illegible]	[illegible]	52·5	50·1	31·2	12·8	55·0	50·[illegible]	·357	4·1	0·8	85	53[illegible]	—	—	1·4	4	5	11	10	—	4·[illegible]	35	6·11
[illegible]	77·2	30·2	14·0	[illegible]	44·1	33·1	19·9	52·4	46·1	·314	3·6	1·[illegible]	79	53[illegible]	114·1	36·4	1·[illegible]	3	6	8	12	2·[illegible]	5·[illegible]	4[illegible]	6·[illegible]
[illegible]	70·2	[illegible]	[illegible]	70·8	[illegible]	[illegible]	16·[illegible]	70·7	44·4	·2[illegible]	3·4	0·8	80	53[illegible]	112·3	37·[illegible]	0·7	4	7	8	11	—	6·4	52	10·4[illegible]
[illegible]	74·4	[illegible]	44·4	63·6	[illegible]	[illegible]	21·0	52·5	45·0	·29[illegible]	3·4	1·1	78	53[illegible]	—	—	1·7	5	7	9	10	—	6·[illegible]	41	5·[illegible]
[illegible]	77·0	[illegible]	41·6	62·[illegible]	45·7	[illegible]	16·0	52·5	44·8	·30	3·4	1·1	76	53[illegible]	112·8	40·[illegible]	1·1	5	6	9	11	—	5·[illegible]	42	7·0[illegible]
[illegible]	76·[illegible]	31·8	44·7	63·4	44·[illegible]	[illegible]	19·1	[illegible]	46·5	·319	3·6	1·0	79	53[illegible]	121·5	37·4	0·7	—	—	—	—	6·[illegible]	6·7	45	6·[illegible]
[illegible]	74·[illegible]	32·6	41·7	67·9	45·2	[illegible]	8·7	[illegible]	44·9	·29[illegible]	3·5	1·[illegible]	74	53[illegible]	108·2	31·[illegible]	—	8	6	8	8	—	6·0	45	6·[illegible]
[illegible]	72·[illegible]	27·9	44·1	61·[illegible]	42·1	37·1	19·8	51·[illegible]	44·8	·29[illegible]	3·[illegible]	0·8	80	538	121·1	36·[illegible]	1·[illegible]	7	7	7	10	—	6·0	47	6·[illegible]
[illegible]	71·0	31·9	40·1	61·[illegible]	45·1	31·[illegible]	15·9	52·7	45·7	·30	3·5	1·[illegible]	77	53[illegible]	112·6	41·2	3·[illegible]	6	7	9	9	2·[illegible]	6·[illegible]	50	9·[illegible]
[illegible]	77·[illegible]	28·0	49·0	61·9	41·[illegible]	40·5	21·8	52·[illegible]	46·7	·32	3·6	0·8	81	538	111·7	40·1	1·4	6	8	6	11	2·[illegible]	[illegible]	40	6·[illegible]
[illegible]	77·1	28·9	46·2	[illegible]	42·9	38·1	20·7	51·2	46·3	·317	3·5	0·7	83	53[illegible]	—	—	—	7	7	8	9	—	6·2	41	6·[illegible]
—	77·0	29·0	46·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	41	7·[illegible]
[illegible]	77·[illegible]	30·0	47·[illegible]	6[illegible]	43·[illegible]	41·[illegible]	22·0	52·[illegible]	46·3	·317	3·6	0·[illegible]	80	53[illegible]	134·5	56·1	1·2	8	9	9	4	—	5·9	50	6·[illegible]
[illegible]	76·6	[illegible]	[illegible]	62·8	41·1	41·7	21·7	50·7	46·8	·3[illegible]	3·7	0·7	85	53[illegible]	—	—	0·[illegible]	8	7	9	7	7·[illegible]	6·[illegible]	5[illegible]	8·99
[illegible]	69·7	34·7	35·0	57·2	43·[illegible]	20·4	10·7	[illegible]	44·8	·29[illegible]	3·5	0·[illegible]	84	54[illegible]	109·1	43·[illegible]	2·[illegible]	4	8	7	11	—	6·[illegible]	38	7·44
[illegible]	70·[illegible]	32·2	[illegible]	[illegible]	[illegible]	[illegible]	13·7	50·5	45·8	·31[illegible]	3·4	0·7	84	542	—	—	1·1	6	7	8	9	7·[illegible]	5·[illegible]	44	7·[illegible]
[illegible]	72·1	28·1	44·0	59·5	41·8	[illegible]	17·2	49·[illegible]	42·7	·27[illegible]	3·1	0·8	78	5[illegible]	—	—	—	5	10	8	7	—	5·1	4[illegible]	11·6[illegible]
[illegible]	73·2	[illegible]	44·2	61·1	44·1	[illegible]	17·[illegible]	51·8	42·5	·28[illegible]	3·[illegible]	1·[illegible]	75	53[illegible]	118·3	—	0·8	7	6	9	9	—	6·[illegible]	53	9·[illegible]
[illegible]	78·2	27·2	[illegible]	[illegible]	42·8	40·[illegible]	20·[illegible]	[illegible]	45·0	·30	3·5	1·0	80	53[illegible]	105·2	39·[illegible]	0·[illegible]	6	9	6	9	2·3	6·2	33	7·10
[illegible]	72·[illegible]	[illegible]	49·5	[illegible]	40·4	40·8	18·2	[illegible]	45·4	·30	3·5	0·6	87	543	114·8	[illegible]	1·7	12	4	11	13	—	6·[illegible]	—	—
[illegible]	[illegible]	33·[illegible]	33·[illegible]	57·2	45·2	28·4	12·0	50·7	44·3	·29[illegible]	[illegible]	0·8	84	541	—	—	1·0	2	9	7	12	—	6·5	44	7·[illegible]
[illegible]	71·[illegible]	36·1	43·2	57·2	45·1	36·4	12·[illegible]	50·[illegible]	44·2	·30	3·4	0·8	83	[illegible]	—	—	—	6	7	8	10	—	6·[illegible]	52	8·[illegible]
[illegible]	71·[illegible]	29·1	42·1	57·8	41·9	32·0	15·9	46·0	42·0	·29[illegible]	3·1	0·[illegible]	77	534	72·6	35·1	1·[illegible]	5	9	9	8	2·5	6·[illegible]	57	6·[illegible]
[illegible]	71·[illegible]	24·5	45·3	55·6	41·1	38·1	18·5	48·7	43·0	·28	3·2	0·7	81	534	99·9	35·1	0·8	3	8	8	10	—	6·[illegible]	54	11·84
[illegible]	76·[illegible]	28·0	48·0	59·4	42·5	36·7	16·5	50·[illegible]	44·3	·28	3·2	1·0	76	542	88·6	40·2	1·[illegible]	5	7	8	10	—	5·7	31	9·[illegible]
[illegible]	75·0	30·5	44·5	59·5	45·0	31·8	14·2	50·6	44·6	·29[illegible]	3·4	0·9	80	53[illegible]	117·6	40·7	—	4	8	5	13	—	7·2	45	10·[illegible]
[illegible]	74·4	32·0	42·4	59·6	44·4	[illegible]	11·[illegible]	50·2	42·0	·29	3·0	1·[illegible]	74	53[illegible]	80·4	—	1·0	4	7	7	[illegible]	—	6·[illegible]	54	9·25
[illegible]	74·6	32·0	42·0	61·3	44·5	[illegible]	16·8	51·9	45·1	·30	3·4	0·[illegible]	78	537	76·7	—	1·[illegible]	5	7	6	12	—	5·[illegible]	43	7·74
[illegible]	73·[illegible]	30·[illegible]	43·0	57·8	42·9	[illegible]	11·9	49·6	42·1	·271	3·0	1·0	75	541	—	—	—	—	—	—	—	—	—	46	10·6[illegible]
[illegible]	75·[illegible]	30·8	44·5	59·2	42·5	[illegible]	[illegible]	49·8	43·2	·28[illegible]	3·2	0·9	80	54[illegible]	112·0	[illegible]	1·4	4	11	5	10	6·5	4·[illegible]	40	7·10
[illegible]	73·7	21·7	52·0	60·6	41·0	40·[illegible]	19·[illegible]	49·8	43·8	·29[illegible]	3·3	0·8	81	53[illegible]	100·2	33·2	0·9	3	13	4	10	3·8	6·5	49	6·98

…res of the air were at Nottingham, 78°·2; at Gloucester and Cambridge, 77°; and at Rugby 76°·6.
…tes of the air were at Rugby, 23°·5; at Carlisle, 2[illegible]°·7; and at Holkham, 23°·7.
…ges of temperatures were at Rugby, 5[illegible]°·1; at Nottingham and Carlisle, 52°, and at Salisbury and Gloucester 49°.
…of temperatures were at Guernsey, 10°·6; at Lowestoft 10°·[illegible] and at Llandudno, 12°.
…of days of rain were at Bolton and Totnes, 57; at Barnstaple and Leicester, 55; and at Plymouth, Bermuda.
…days of rain were at Osborne, 32; at Strathfield Turgiss, Gloucester, and Silloth, 40; and at Royston, Bedford, …l.
…rain in the quarter were at Bolton, 17·15 inches; at Stonyhurst, 14·49 inches; and at Marlborough, 13·48 inches.
…in the quarter were at Greenwich, 6·13 inches; at Royston, 6·23 inches; at Camden Square, 6·33 inches.

…ARTERLY METEOROLOGICAL TABLE for different PARALLELS of LATITUDE.

	Mean Pressure of dry Air reduced to the level of the Sea.	Mean of all Highest Readings of the Thermometer.	Mean of all Lowest Readings of the Thermometer.	Mean Range of Temperature in the Quarter.	Mean of all Highest.	Mean of all Lowest.	Mean Monthly Range of Temperature.	Mean Daily Range of Temperature.	Mean Temperature of the Air.	Mean Temperature of the Dew Point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Mean Reading of Maximum in Rays of Sun.	Mean Reading of Minimum on Grass.	Wind. Mean Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Mean Number of Days it fell.	Rain. Mean Amount collected.
	in.	°	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
-	29·530	68·6	37·0	31·6	58·9	48·5	23·0	10·6	52·4	48·8	·347	3·9	0·5	88	536	109·7	45·4	1·0	6	7	9	9	3·6	5·4	50	[illegible]
-	29·598	71·6	[illegible]4·6	37·0	61·0	46·5	30·3	14·5	52·2	47·1	·327	3·7	0·8	83	538	117·3	40·8	1·5	5	7	8	10	5·0	6·0	47	[illegible]
-	29·591	73·8	30·8	43·0	62·8	44·1	35·7	18·7	52·5	45·0	·312	3·5	1·0	79	537	114·4	37·6	1·4	6	6	8	10	4·4	6·2	46	[illegible]
-	29·575	74·2	29·1	45·1	61·4	43·5	36·5	17·9	51·1	45·2	·301	3·4	0·9	81	537	115·5	39·6	1·0	6	5	5	8	5·5	6·0	46	[illegible]
-	29·588	73·1	30·0	43·1	58·9	43·8	33·2	15·1	50·2	43·5	·285	3·2	0·9	79	537	89·3	38·8	1·2	4	8	7	11	3·5	6·3	50	10·[illegible]
-	29·563	75·5	25·3	50·2	59·9	41·8	38·1	18·1	49·6	43·3	·28[illegible]	3·3	0·9	81	542	106·1	36·4	0·8	3	12	5	10	3·2	5·8	45	7·[illegible]
[illegible]	29·512	70·7	27·1	43·6	57·0	42·1	32·9	14·9	48·2	42·9	·262	3·2	0·7	82	540	96·2	37·7	1·1	7	7	8	9	5·0	6·8	[illegible]	9·[illegible]
[illegible]	29·661	76·0	31·5	44·5	59·9	43·8	35·7	16·1	50·6	44·4	·297	3·5	0·8	80	539	104·0	35·6	1·2	7	8	6	9	4·6	6·4	41	5·[illegible]
[illegible]	29·705	78·6	26·5	51·9	61·0	43·1	41·8	17·9	51·0	43·9	·294	3·3	1·0	77	541	107·2	38·9	1·2	6	9	6	10	4·[illegible]	6·9	56	5·[illegible]
[illegible]	29·583	73·6	29·9	43·7	60·8	43·9	34·8	16·7	51·1	41·8	·303	3·4	0·9	81	538	108·5	38·6	1·2	5	6	7	10	4·7	6·1	47	[illegible]

METEOROLOGY OF ENGLAND,

DURING THE QUARTER ENDING SEPTEMBER 30, 1882.

REMARKS ON THE WEATHER DURING THE QUARTER ENDING SEPTEMBER 30TH, 1882.

By JAMES GLAISHER, ESQ., F.R.S., *&c.*

With the exception of the first three days, which were fine and warm, the month of July was cold; the maximum temperature in the month, at many stations south of latitude 52°, did not rise above 73° or 74°, and it exceeded 78° at a very few places indeed over the country; it was in this respect a great contrast to July 1881, in which month the temperature exceeded 90° on two days, and was above 80° on many days. The atmospheric pressure was generally below its average, and rain fell in showers on 17 to 20 days at stations situated in south of England, the number gradually increasing to 25, and to 29 at northern stations. The wind was mostly from the S.W., frequently blowing strongly, and there was almost a total absence of wind from the east. The month was cold, wet, and ungenial—a bad month for haymaking, and many fields remained uncut at the end of the month.

The month of August was moderately fine at the beginning, but cold and showery from the 14th; the maximum temperatures in this month were low, at many stations not reaching 80° during the whole month, and the stations at which it exceeded 80° were few in number. The fall of rain was generally less than the average. The atmospheric pressure was above its average till the 11th, and was, with the exception of the 17th, constantly below during the remainder of the month.

The weather in the month of September, during the first week was moderately fine, but from the 7th was cold and unsettled; the highest temperature reached in the month was less than 70° at several stations, but exceeded 70° generally; the mean temperature of the month was lower than of any other September back to 1863, excepting that of 1877; the atmospheric pressure was constantly below its average from the 10th to the 29th; rain was generally less than the average, but was above at a few stations. The month on the whole was cold, and the air more humid than usual, particularly in the Midland Counties, and in the early afternoon hours, causing harvest operations to be slow.

Upon the whole the unsettled weather which began in June has continued till the end of this quarter; the number of days within these four months which could be described as summerlike have been very few.

About London the mean daily temperature of the air was slightly above its average till the 3rd day; from the 3rd to the 28th, with the exceptions of the 14th and 27th, which were slightly above, the temperature was always low, the average daily deficiency of these 25 days was 2°·8; from July 29th to August 14th, there were 2 or 3 days together, warm, and then 2 or 3 days cold, very nearly balancing each other; from August 15th to the end of the month it was cold, the average deficiency of daily temperature being 2°·6; from September 1 to 6, the average daily excess of temperature was 1°; and from the 7th to the end of the month it was cold; on the 14th the daily temperature was 12° below its average, and the daily deficiency of those 28 days was 2°·8.

The mean temperature of the air for July was 60°·4, being 1°·2 and 1°·8 below the average of 111 years and 41 years respectively; it was 5°·0 lower than in the year 1881, 1°·3 lower than in 1880, but 2°·3 higher than in 1879.

The mean temperature of the air for August was 59°·6, being 1°·3 and 1°·9 below the averages of 111 years and 41 years respectively; it was 0°·5 higher than in 1881, but 3°·2 and 0°·3 lower than in 1880 and 1879, respectively.

The mean temperature of the air for September was 54°·3, being 2°·2 and 2°·8 below the averages of 111 years and 41 years respectively; it was 1°·1, 5°·4, and 2°·0 lower than in 1881, 1880, and 1879, respectively, and colder than any September back to 1877, when it was 52°·9.

The mean temperature for the quarter was 58°·1, being 1°·6 and 2°·1 below the average of 111 years and 41 years, respectively.

The mean high day temperature of the air in July was 71°·1, being 3°·2 below the average of 41 years; in August it was 70°·5, being 2°·4 below the average, and in September it was 64°·0, being 3°·5 below the average.

The mean low night temperature of the air in July was 52°·5, being 0°·7 below its average; in August it was 51°·7, being 1°·5 below its average, and in September it was 46°·6, being 2°·6 below its average; therefore both the days and nights have been cold throughout the quarter.

The mean daily range of temperature in July was 2°·4 smaller than the average, and in August and September, it was 0°·9 smaller than the average.

The mean temperature of the air in July was 3°·9 higher than in June, in August it was 0°·8 lower than in July, in September it was 5°·3 lower than in August.

(From the preceding 41 years observations the increase of temperature from June to July is 3°·3, the decrease from July to August is 0°·7, and the decrease from August to September is 4°·4.)

From June to July at stations south of 51°, there was a mean increase of 2°·8 of temperature; and the mean increase north of that parallel was 4°·0; from July to August at stations

south of 51° there was a further increase of 1°·3, but at stations north of 52°, the mean temperature of July and August was nearly the same; from August to September there was a decrease of temperature nearly the same at all stations to the mean value of 4°·7.

About London the mean daily pressure of the atmosphere till July 3rd was above the average by 0·12 in.; from the 4th to the 18th it was below by 0·33 in.; then for three days it was above by 0·11 in.; it was four days 0·15 in. below; from July 26th to August 11th, it was above the average by 0·29 in., and for the 23 days ending September 3rd, there was an average daily deficiency of 0·24 in. this was followed by six days of an excess of pressure averaging 0·18 in. daily, and then to the end of the quarter there was a daily deficiency of 0·22 in.

The mean reading of the barometer for the month of July at the height of 159 feet above the sea was 29·700 in., being 0·099 in. below the average of 41 years; it was 0·125 in. below that of 1881; and 0·027 in. below that of 1880.

The mean reading of the barometer in August was 29·740 in. being 0·042 in. below the average in 41 years; it was 0·064 in. above that of 1881, and 0·078 in. below that of 1880.

The mean reading of the barometer in September was 29·689 in. being 0·117 in. below the average of 41 years; it was 0·114 in. below that of 1881, and 0·118 in. below that of 1880.

1882. Months.	Temperature of Air. Mean.	Air. Diff. from average of 111 years.	Air. Diff. from average of 41 years.	Evaporation. Mean.	Evaporation. Diff. from average of 41 years.	Dew Point. Mean.	Dew Point. Diff. from average of 41 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 41 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 41 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour. Diff. from average of 41 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
July -	60·4	−1·2	−1·8	56·6	−1·2	53·2	−0·8	18·6	−2·4	·406	−0·015	4·5	−0·3
Aug. -	59·6	−1·3	−1·9	56·3	−1·2	53·4	−0·6	18·8	−0·9	·409	−0·011	4·8	−0·1
Sept. -	54·3	−2·2	−2·8	52·0	−2·0	49·8	−1·3	17·4	−0·9	·358	−0·022	4·0	−0·4
Means -	58·1	−1·6	−2·2	55·0	−1·5	52·1	−0·9	18·3	−1·4	·391	−0·019	4·4	−0·3

1882. Months.	Degree of Humidity. Mean.	Humidity. Diff. from average of 41 years.	Reading of Barometer. Mean.	Barometer. Diff. from average of 41 years.	Weight of a Cubic Foot of Air. Mean.	Weight. Diff. from average of 41 years.	Rain. Amount.	Rain. Diff. from average of 66 years.	Daily Horizontal movement of the Air.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
July -	78	+ 3	29·700	−0·099	528	0	2·45	−0·11	291	0	1	30	26·9	54·9
Aug. -	80	+ 3	29·740	−0·042	529	+ 1	1·16	−1·29	303	0	7	24	33·0	55·5
Sept. -	85	+ 4	29·687	−0·117	531	+ 1	2·40	−0·01	228	1	21	8	29·0	53·1
Means -	81	+ 3	29·700	−0·086	530	+ 1	Sum 6·01	Sum −1·41	Mean 824	Sum 1	Sum 29	Sum 62	Lowest 29·0	Highest 55·5

NOTE.—In reading this table it will be borne in mind that the plus sign (+) signifies *above* the average, and that the minus sign (−) signifies *below* the average.

The average duration of the different directions of the wind referred to eight points of the compass, and the duration of each direction in each month in the quarter, were as follow:—

Direction of Wind.	June. 1882.	June. Average.	June. Departure from Average.	August. 1882.	August. Average.	August. Departure from Average.	September. 1882.	September. Average.	September. Departure from Average.
	d.	d.	d.	d.	d.	d.	d.	d.	d.
N.W.	1½	2¾	−1¼	4½	2½	+2	6	2	+4
N.	1	3¾	−2¾	4¼	3½	+ ¾	3½	4¼	− ¾
N.E.	0	3¾	−3¾	¼	3½	−3¼	3	5¼	−2¼
E.	0	1½	−1½	3	1½	+1½	3½	2¼	+1¼
S.E.	0	1	−1	¼	1½	−1¼	1½	2	− ½
S.	8	3	+5	1¼	3½	−2¼	5	3	+2
S.W.	13¼	11	+2¼	10	10¼	− ¼	6	8	−2
W.	7¼	4¼	+3	7½	4½	+3	1½	3	−1½

The plus sign (+) denotes excesses over averages; the largest numbers affected with this sign in the month of July are opposite to S., S.W. and W.; in August to N.W. and W.; and in September to N. and S.

The minus sign (−) denotes deficiencies below averages. In July the largest numbers are *opposite to N. and N.E.*; in August to N.E. and S.; and in September to N.E. and S.W.

The atmospheric pressure in July was 0·035 in. below that of June, that in August was 0·040 in. above that of July, and that in September was 0·053 in. lower than in August.

(From the preceding 41 years observations the mean pressure in July is 0·007 in. below that in June; in August is 0·017 in. below that in July, and September is 0·022 in. above that in August.)

From June to July there was a decrease of pressure, at all stations; at those south of 51° and north 53°, of 0·07 in., and of 0·04 in. at those between these parallels; from July to August there was an increase of 0·09 in. south of 51° and north of 53°, and of 0·05 between 51° and 53°; and from August to September there was a decrease of 0·08 in. at southern stations decreasing gradually to 0·01 in. at northern stations.

Thunderstorms occurred in July on the 7th at Royston, Somerleyton, and Lowestoft; on the 8th at Oxford, Royston, Cambridge, Wolverhampton, and Liverpool; on the 10th at Whitchurch, Oxford, Somerleyton, and Lowestoft; on the 24th at Royston, Lowestoft, and Cambridge; and on the 25th at Osborne, Salisbury, and Wolverhampton.

In August on the 12th at Plymouth, Totnes, Torquay, Osborne, Salisbury, Bath, Marlborough, and Wolverhampton; on the 13th at Bath, Liverpool, Llandudno, and Bradford; on the 14th at Halifax: on the 15th at Rugby; on the 19th at Somerleyton; and on the 25th and 30th at Cardington.

In September on the 1st at Plymouth; on the 2nd at Truro; on the 3rd at Leicester and Wolverhampton; on the 12th at Truro; on the 13th and 14th at Guernsey; on the 14th at Osborne and Bournemouth; on the 26th at Halifax and Bradford; and on the 27th at Bradford and Leeds.

Thunder was heard but lightning was not seen in July on the 1st at Wolverhampton; on the 2nd at Salisbury, Whitchurch, and Wolverhampton; on the 5th at Oxford; on the 6th at Somerleyton, Cambridge, and Liverpool; on the 7th at Barnet, Lowestoft, Cambridge, and Liverpool; on the 8th at Oxford, Somerleyton, and Cambridge; on the 9th at Somerleyton, Lowestoft, and Cambridge; on the 10th at Lowestoft and Wolverhampton; on the 11th at Oxford, and Cambridge; on the 12th at Cambridge; on the 24th at Salisbury, Strathfield Turgiss, Oxford, and Barnet; on the 25th at Oxford.

In August on the 9th at Rugby; on the 11th at Whitchurch; on the 13th at Somerleyton, Rugby, Bolton, and Carlisle; on the 14th at Somerleyton, Cambridge, Llandudno, and Carlisle; on the 25th at Rugby and Cambridge; and on the 30th at Somerleyton.

In September on the 11th at Strathfield Turgiss; on the 12th at Salisbury and Whitchurch; on the 14th at Torquay and Cambridge; and on the 27th at Burslem and Halifax.

Lightning was seen but thunder was not heard in July, on the 11th at Cambridge; and on the 30th at Whitchurch.

In August, on the 11th at Whitchurch; on the 12th at Torquay, Barnet, and Cambridge; on the 13th at Truro, Torquay and Whitchurch; on the 16th at Carlisle; on the 20th at Oxford; and on the 25th at Marlborough.

In September, on the 12th at Guernsey, Plymouth, Totness, Torquay, and Marlborough: on the 13th at Plymouth, Totnes, Torquay, Ventnor, Bournemouth, Strathfield Turgiss, Salisbury, Barnet, and Oxford; on the 14th at Plymouth, Totnes, Salisbury, Barnet, and Cambridge; on the 24th at Guernsey.

Solar halos were seen in July, on the 1st at Barnet; on the 12th, 19th, and 22nd at Oxford; and on the 7th and 31st at Bernerside.

In August on the 13th at Oxford; and on the 30th at Torquay.

In September on the 6th at Strathfield Turgiss and Halifax; on the 8th, 10th, and 13th at Halifax; on the 17th at Torquay and Oxford; and on the 19th, 28th, and 29th at Torquay.

Lunar halos were seen in August on the 31st at Oxford.

In September, on the 25th at Oxford; on the 26th at Torquay and Oxford; on the 28th at Cambridge; and on the 29th at Oxford.

Hail fell in July on the 6th at Lowestoft; on the 7th at Royston and Lowestoft; on the 10th at Whitchurch and Oxford; on the 20th at Liverpool; and on the 25th at Osborne.

In August on the 13th and 24th at Llandudno, and on the 29th at Barnet.

In September on the 12th at Guernsey and Truro; on the 13th at Truro and Torquay; and on the 27th at Torquay.

Fog prevailed in July on the 1st, 2nd, and 28th at Guernsey, on the 29th at Guernsey, Strathfield Turgiss, Whitchurch, Oxford, and Cambridge; and on the 30th at Guernsey.

In August on the 1st at Bath, on the 8th at Marlborough and Bolton; on the 9th at Totnes and Bath; on the 10th at Bath; on the 11th at Cambridge; on the 12th at Torquay, Bath, Marlborough, and Cardington; on the 13th at Cambridge; on the 17th and 18th at Torquay; and on the 19th at Bath.

In September on the 1st at Torquay and Wolverhampton; on the 4th, 6th, and 7th at Leicester; on the 8th at Cambridge; on the 10th at Oxford, Royston, Cambridge, Leicester, and Wolverhampton; on the 11th at Cambridge and Bolton; on the 12th and 13th at Bolton; on the 14th at Oxford; on the 15th at Strathfield Turgiss, Oxford, Cambridge, Leicester, Wolverhampton, and Bolton; on the 16th at Oxford, Cambridge, and Leicester; on the 17th at Whitchurch, Oxford, and Cambridge; on the 19th at Whitchurch and Wolverhampton; on the 22nd at Bolton; on the 23rd, 25th, and 26th at Totnes; on the 26th at Cambridge; on the 27th at Wolverhampton; and on the 29th at Bolton.

MONTHLY METEOROLOGICAL TABLE FOR THE QUARTER ENDING SEPTEMBER 30TH, 1882.

The Observations have been reduced to Mean values by Glaisher's Barometrical and Diurnal Range Tables, and the Hygrometrical results have been deduced from the sixth edition of his Hygrometrical Tables.

NAMES of STATIONS and OBSERVERS.	Height of Station above Sea Level.	Year 1882. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean Of all Highest.	Temperature of Air in Month. Mean Of all Lowest.	Temperature of Air in Month. Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity, Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	Wind. Relative Proportion of E.	Wind. Relative Proportion of S.	Wind. Relative Proportion of W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									
GUERNSEY, ADOLPHUS COLLENETTE, ESQ., F.M.S.	270	July	29·643	1·057	68·2	50·6	17·6	64·8	53·9	10·9	58·0	53·7	·412	4·6	0·8	85	529	118·4	49·4	1·0	4	1	10	16	3·2	5·2	19	2·82
		Aug.	29·711	1·202	78·0	51·0	27·0	66·0	55·2	10·8	59·5	54·4	·424	4·7	1·0	84	529	118·1	47·9	1·2	5	3	2	21	3·2	5·5	19	3·45
		Sept.	29·599	0·995	67·0	41·5	25·5	62·0	51·2	10·8	55·9	51·1	·377	4·2	0·8	84	531	109·3	49·8	0·8	11	3	6	10	2·7	6·6	19	3·94
TRURO (Cornwall), C. BARHAM, ESQ., M.D., F.M.S.	43	July	29·782	1·120	73·0	42·0	31·0	67·2	53·0	14·2	57·6	52·1	·385	4·3	1·0	82	532	—	—	2·7	5	0	8	18	—	7·0	19	4·15
		Aug.	29·883	1·090	78·0	47·0	31·0	68·7	54·6	14·1	58·9	53·2	·406	4·5	1·1	81	533	—	—	2·4	7	3	6	16	—	6·8	13	2·66
		Sept.	29·815	1·045	72·0	35·0	37·0	63·8	47·8	16·0	54·2	49·4	·353	4·0	0·8	84	547	—	—	2·3	8	6	6	10	—	6·9	15	4·52
PLYMOUTH (Devon), J. MERRIFIELD, ESQ., LL.D., F.R.A.S., F.M.S.	69	July	29·781	1·116	72·0	46·3	25·7	66·3	54·7	11·6	58·4	54·9	·435	4·8	0·7	89	531	—	—	1·2	3	2	22	4	—	7·0	18	3·79
		Aug.	29·876	0·981	78·1	47·0	31·1	68·0	54·8	13·2	60·5	55·1	·428	4·8	1·1	83	531	—	—	1·5	7	3	6	16	—	6·8	14	1·43
		Sept.	29·801	1·051	66·0	37·8	28·2	61·7	47·9	13·8	54·3	49·1	·348	3·9	0·9	81	537	—	—	1·2	10	7	4	9	—	5·6	17	5·47
TOTNES (Devon), T. H. EDMONDS, ESQ.	107	July	29·784	1·086	75·6	41·8	33·8	67·2	52·1	15·1	58·4	51·9	·388	4·3	1·2	79	533	—	—	2·8	3	2	15	11	—	6·4	20	4·31
		Aug.	29·819	1·089	80·2	45·4	34·8	68·4	51·9	16·5	59·5	52·1	·390	4·6	1·3	83	532	—	—	2·5	6	4	3	18	—	6·0	16	2·72
		Sept.	29·793	1·070	70·0	30·4	39·6	63·5	44·3	19·2	53·9	47·0	·321	3·6	1·1	77	537	—	—	1·9	10	5	5	10	—	4·7	15	5·34
TORQUAY, Babbacombe (Devon), EDWIN E. GLYDE, ESQ., F.M.S.	305	July	29·562	1·100	72·7	47·0	25·7	63·9	52·6	13·3	57·9	52·3	·392	4·4	1·0	81	528	128·0	47·6	1·5	4	1	11	15	3·9	6·7	17	3·38
		Aug.	29·640	1·036	78·2	47·9	30·3	67·4	53·2	14·2	59·2	52·2	·390	4·4	1·3	75	528	125·8	45·7	1·4	6	5	5	15	4·6	6·0	14	2·09
		Sept.	29·556	1·142	66·9	36·9	30·0	61·8	47·5	14·3	54·2	47·1	·332	3·7	1·1	77	532	113·4	39·7	1·3	8	5	6	11	4·9	5·6	16	4·40
VENTNOR, (Isle of Wight) (Royal National Hospital for Consumption), HARTLEY SAGAR, ESQ.	80	July	29·789	1·040	72·1	50·4	21·7	65·5	54·9	10·6	58·4	54·2	·421	4·7	0·8	86	532	—	—	1·5	2	2	10	17	5·7	7·0	16	2·75
		Aug.	29·844	0·808	77·2	51·4	25·8	68·2	55·8	12·4	60·2	53·4	·410	4·6	1·3	79	531	—	—	1·7	8	3	3	17	6·0	7·0	17	2·13
		Sept.	29·706	1·132	71·8	44·2	27·6	64·3	51·5	12·8	56·6	53·6	·411	4·6	0·5	89	533	—	—	1·9	8	8	3	11	5·8	5·8	11	2·59
EASTBOURNE (Sussex), MISS W. L. HALL.	12	July	29·841	1·042	75·0	46·5	28·5	68·2	53·5	14·7	59·5	55·6	·441	5·0	0·8	87	531	117·5	50·8	0·3	3	1	11	16	1·8	—	19	2·48
		Aug.	29·864	0·904	75·9	46·3	29·6	68·5	53·6	14·9	59·9	53·3	·411	4·6	1·2	80	531	117·8	47·0	0·4	7	1	5	18	1·7	—	13	2·83
		Sept.	29·708	1·126	69·1	46·0	23·1	63·7	49·7	14·0	56·0	49·4	·355	3·9	1·1	71	534	112·0	48·3	0·3	9	6	4	11	0·9	—	10	3·24
OSBORNE (Isle of Wight), J. R. MANN, ESQ.	172	July	29·702	1·122	77·4	49·6	27·8	69·3	53·8	15·5	59·6	56·0	·447	5·0	0·7	88	529	120·5	52·1	0·1	2	2	15	12	—	5·9	17	2·51
		Aug.	29·738	0·924	84·9	48·2	36·7	70·7	53·6	17·1	60·3	55·8	·440	5·1	0·8	85	529	122·6	49·8	0·2	5	4	8	14	—	5·4	14	1·96
		Sept.	29·681	1·138	72·7	39·3	33·4	65·8	48·4	17·4	55·8	54·1	·420	4·8	0·2	94	532	115·8	44·9	0·1	9	3	7	11	—	5·6	12	1·77
SOUTHBOURNE ON SEA (Hants), T. A. COMPTON, ESQ., M.D., B.A., F.M.S.	95	July	29·768	1·080	73·1	48·0	25·1	64·7	54·1	10·6	58·5	53·5	·408	4·5	1·0	84	531	—	—	1·6	4	4	12	11	—	6·9	21	2·26
		Aug.	29·838	0·908	79·6	46·0	33·6	67·7	52·9	14·8	59·4	52·2	·392	4·4	1·3	77	532	—	—	1·5	6	5	4	16	—	6·0	18	1·83
		Sept.	29·750	1·120	67·1	35·0	32·1	62·8	46·7	16·1	54·5	47·6	·328	3·7	1·1	77	535	—	—	1·2	12	4	6	8	—	4·5	11	2·75
SALISBURY (Wilton House), Wilts, THOMAS CHALLIS, ESQ.	186	July	29·670	1·126	77·0	43·0	34·0	70·6	49·4	21·2	58·8	54·3	·422	4·6	1·0	84	529	120·5	44·2	1·2	5	3	8	15	—	6·3	22	3·68
		Aug.	29·738	1·086	82·0	43·0	39·0	71·2	48·4	22·8	58·7	53·0	·403	4·5	1·1	81	531	113·4	46·3	1·3	9	4	6	12	—	5·9	15	1·63
		Sept.	29·650	1·120	71·0	30·0	41·0	65·5	41·7	23·8	53·4	47·2	·332	3·8	0·8	82	535	103·4	40·1	1·1	15	3	7	5	—	4·9	13	2·75
BARNSTAPLE (Devon), WILLIAM KNILL, ESQ.	43	July	29·806	1·130	77·0	47·0	30·0	68·5	56·2	12·3	60·7	56·9	·465	5·2	0·8	88	529	—	—	1·2	1	1	13	16	—	4·8	21	5·75
		Aug.	29·909	1·070	82·0	36·0	46·0	69·9	57·0	12·9	61·4	55·1	·434	4·8	1·8	80	531	—	—	1·1	6	3	6	18	—	3·7	17	5·86
		Sept.	29·821	1·060	70·0	40·0	30·0	64·0	51·2	12·8	56·5	50·5	·368	4·1	1·0	79	534	—	—	1·1	8	4	9	9	—	3·3	15	3·94
STRATHFIELD TURGISS (Hants), REV. C. H. GRIFFITH, M.A., F.M.S.	197	July	29·669	1·098	77·2	35·3	41·9	70·2	50·9	19·3	59·9	53·0	·408	4·5	1·3	78	528	122·8	44·9	1·1	3	2	12	14	2·8	6·4	16	1·66
		Aug.	29·706	0·934	83·2	44·2	39·0	70·1	50·5	19·6	59·9	51·8	·386	4·8	1·5	73	529	115·8	44·5	1·0	6	3	7	16	2·4	5·6	18	1·62
		Sept.	29·660	1·148	69·3	32·7	36·6	64·3	43·8	20·5	54·1	49·4	·343	4·0	0·7	84	534	110·6	37·1	0·9	7	6	5	12	1·8	4·1	12	2·58

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1882. Months.	Pressure of Atmosphere in Month. Mean.	Pressure Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean Of all Highest.	Mean Of all Lowest.	Daily Range.	Mean Temperature. Air.	Dew Point.	Vapour. Elastic Force.	In a Cubic foot of Air. Mean.	Short of Saturation.	Mean Degree of Humidity. Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Minimum on Grass.	Wind. Estimated Strength.	Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
BATH (Somerset), St. Gregory's College, Downside, Rev. T. J. Almond, O.S.B., F.M.S.	596	June	29·269	0·797	70·1	40·8	29·3	60·5	47·4	12·9	52·5	47·9	·334	4·0	0·7	84	529	111·4	45·8	1·5	3	2	8	17	—	6·9	21	5·36
		July	29·214	1·122	72·4	47·9	24·5	64·5	52·7	11·8	54·9	54·5	·395	4·4	0·8	87	523	—	—	1·2	4	2	12	13	—	7·3	17	4·38
		Aug.	29·254	0·936	72·4	46·4	26·0	61·3	52·5	11·8	57·2	51·8	·386	4·3	1·0	82	523	110·8	47·7	1·5	6	3	7	15	—	6·6	14	3·87
		Sept.	29·221	1·155	61·8	37·2	27·6	60·0	45·4	14·6	52·2	47·2	·326	5·6	0·8	81	528	109·2	40·9	1·1	10	4	5	11	—	5·0	—	3·70
MARLBOROUGH (Wilts), Rev. Thomas A. Preston, M.A., F.M.S.	456	July	29·344	1·140	73·4	44·4	29·0	66·8	51·1	15·7	57·7	52·2	·386	4·3	1·0	83	535	123·0	47·6	0·9	3	4	12	12	—	7·5	23	3·81
		Aug.	29·410	0·958	78·7	43·0	35·7	66·7	50·4	16·3	57·6	51·5	·381	4·4	1·1	80	526	117·3	—	0·4	9	4	6	12	—	5·8	13	2·37
		Sept.	29·361	1·141	66·5	34·7	32·8	61·8	44·6	17·2	52·8	47·1	·324	3·7	0·8	81	530	110·3	41·7	0·5	8	6	7	9	—	5·5	12	3·20
WHITCHURCH RECTORY (Oxon), (near Reading). Rev. J. Slatter, M.A., F.M.S.	150	July	29·715	1·065	78·2	42·4	35·8	71·8	49·7	22·1	59·8	53·8	·434	4·6	1·1	82	529	—	—	1·4	3	4	12	12	—	7·0	24	2·43
		Aug.	29·782	1·026	80·1	43·9	36·2	69·9	49·1	20·8	58·6	51·8	·385	4·3	1·2	78	532	—	—	1·6	7	3	6	15	—	6·6	12	1·90
		Sept.	29·716	1·213	71·2	31·3	39·9	63·3	43·7	19·6	55·8	48·6	·342	3·9	0·7	82	536	—	—	1·2	9	7	6	8	—	5·3	11	2·39
BLACKHEATH (Kent), James Glaisher, Esq., F.R.S.	150	July	29·708	1·080	78·0	48·0	30·0	70·4	53·7	16·7	60·6	53·0	·402	4·5	1·4	76	529	126·6	50·0	1·0	2	0	14	15	—	5·1	19	2·66
		Aug.	29·746	1·009	81·0	48·0	33·0	69·3	53·5	15·8	59·7	51·0	·375	4·2	1·6	73	530	114·1	48·5	1·1	6	5	6	14	—	6·0	15	1·06
		Sept.	29·620	1·139	71·0	37·5	33·5	63·2	48·3	14·9	54·7	48·7	·352	4·0	0·9	82	534	98·5	41·8	0·8	8	6	9	7	—	6·1	15	2·81
ROYAL OBSERVATORY, Greenwich, W. H. M. Christie, M.A., F.R.S., Astronomer Royal.	159	July	29·700	1·091	78·7	45·7	33·0	71·1	52·5	18·6	60·4	53·2	·406	4·5	1·3	78	528	131·0	47·7	—	—	—	—	—	6·9	6·5	19	2·45
		Aug.	29·710	1·001	81·0	44·0	37·0	70·5	51·7	18·8	59·6	53·4	·409	4·6	1·1	80	529	121·5	42·8	—	—	—	—	—	4·2	7·0	15	1·16
		Sept.	29·687	1·153	71·1	36·7	34·4	64·0	46·6	17·4	54·3	49·5	·358	4·0	0·7	85	534	110·2	37·8	—	—	—	—	—	2·7	6·9	14	2·40
CAMDEN SQUARE (London), G. J. Symons, Esq., F.R.S., F.M.S.	123	July	29·738	1·108	77·8	46·0	31·8	71·5	53·0	18·5	60·4	52·0	·388	4·4	1·3	74	529	116·4	50·3	—	6	3	7	15	—	6·1	18	2·95
		Aug.	29·779	1·028	80·8	45·0	35·8	70·6	52·7	17·9	61·3	51·7	·384	4·2	1·6	72	530	111·8	49·3	—	9	4	6	12	—	6·4	12	1·48
		Sept.	29·727	1·170	70·6	37·8	32·8	64·7	47·3	17·4	55·2	48·1	·337	3·8	1·1	78	534	99·7	42·8	—	17	4	4	5	—	6·0	9	2·39
BARNET (Gas Works), T. H. Martin, Esq., C.E.	212	July	29·668	1·081	76·1	40·0	36·1	69·9	50·0	19·9	58·6	53·3	·408	4·5	1·0	83	529	134·9	43·8	1·2	4	2	7	18	—	6·4	17	1·95
		Aug.	29·710	1·069	79·5	37·8	41·7	69·1	49·7	19·7	58·2	50·6	·370	4·1	1·3	76	531	124·6	41·2	1·6	13	3	3	12	—	7·0	11	1·25
		Sept.	29·657	1·158	70·0	32·5	37·5	63·7	43·3	20·4	53·0	48·4	·340	3·8	0·7	84	535	110·7	36·6	0·8	9	11	4	6	—	6·3	10	2·72
OXFORD (The Observatory), E. J. Stone, Esq., M.A., F.R.S.	210	July	29·630	1·140	74·3	48·0	26·3	67·9	53·1	14·8	60·0	54·4	·423	4·7	1·1	82	527	121·9	49·3	2·8	2	3	18	8	0·8	7·0	19	3·16
		Aug.	29·680	1·075	78·7	46·3	32·4	68·0	52·8	15·2	60·0	53·0	·402	4·5	1·3	77	528	117·1	47·0	3·5	4	3	11	13	1·4	6·6	10	0·94
		Sept.	29·656	1·170	67·4	35·7	31·7	63·1	47·0	16·1	54·6	49·5	·350	4·0	0·9	82	533	111·2	40·3	2·0	8	7	7	8	0·7	6·0	14	2·41
BURSLEM, J. E. Worth, Esq., C.E.	550	July	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		Aug.	29·279	1·136	75·8	44·4	31·4	65·8	51·5	14·3	56·8	51·6	·383	4·6	0·9	81	523	—	—	0·4	8	2	8	13	—	7·3	22	3·47
		Sept.	29·222	1·173	66·6	37·4	29·2	60·5	45·8	11·7	52·4	44·0	·311	3·5	1·0	79	529	—	—	0·3	8	5	11	6	—	5·8	18	2·10
ROYSTON (Hertfordshire), Hale Wortham, Esq., F.R.A.S., F.M.S.	269	July	29·690	1·129	78·7	43·1	35·6	71·7	51·4	20·3	59·2	53·0	·402	4·6	1·0	80	528	—	—	—	4	2	12	13	—	6·6	16	1·92
		Aug.	29·658	1·081	82·1	43·8	38·3	66·6	51·5	15·1	57·9	52·1	·389	4·3	1·1	81	530	—	—	—	6	2	8	15	—	6·9	9	1·12
		Sept.	29·597	1·154	70·6	36·0	34·6	63·8	45·5	18·3	53·6	47·9	·330	3·7	0·9	80	534	—	—	—	10	5	5	10	—	6·0	11	1·69
BEDFORD, Cardington, Mr. J. McLaren, Assistant to S. Whitbread, Esq., M.P.	105	July	29·707	1·082	78·6	42·4	36·2	71·2	51·0	20·2	60·4	51·7	·424	4·7	1·1	81	528	113·3	50·4	1·7	2	2	11	16	—	6·7	20	3·20
		Aug.	29·752	1·058	79·0	42·0	37·0	69·2	50·6	18·6	59·0	52·9	·430	4·8	0·8	87	530	103·2	45·6	1·8	9	2	5	15	—	7·0	15	1·94
		Sept.	29·715	1·261	70·0	34·0	36·0	64·4	44·8	19·6	54·3	48·4	·354	4·1	1·1	81	535	90·3	41·6	0·8	10	5	8	7	—	6·2	13	2·67
CAMBRIDGE (Trinity College), J. W. L. Glaisher, Esq., M.A., F.R.S.	40	July	29·787	1·090	80·5	41·0	39·5	73·7	51·9	21·8	60·8	53·2	·405	4·5	1·4	76	529	141·7	46·7	1·0	5	5	14	9	—	6·0	18	2·09
		Aug.	29·826	1·186	85·0	40·0	45·0	72·5	51·4	21·1	60·1	52·6	·397	4·4	1·4	76	531	131·8	45·6	1·2	9	3	8	11	—	7·0	17	1·78
		Sept.	29·790	1·172	73·5	34·5	40·0	66·3	45·0	21·3	54·5	50·6	·371	4·2	0·6	87	536	120·7	38·1	0·9	10	7	8	5	—	5·9	13	2·03
RUGBY (Warwickshire), Stockton, The Rectory, Rev. W. Tuckwell.	289	July	29·425	1·280	77·0	43·5	33·5	70·3	50·0	20·3	59·2	54·2	·422	4·8	1·0	85	524	—	—	0·6	3	2	16	10	6·9	7·9	21	2·88
		Aug.	29·479	1·062	80·8	40·8	40·0	68·9	49·6	19·3	57·7	52·4	·394	4·4	0·9	82	528	—	—	0·7	7	4	7	13	6·7	8·4	12	1·45
		Sept.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
LOWESTOFT (Suffolk), S. H. Miller, Esq., F.R.A.S., F.M.S.	89	July	29·746	1·156	73·0	43·5	29·5	67·1	52·3	14·8	58·9	52·3	·383	4·3	1·3	78	531	118·9	40·9	0·6	1	2	11	16	—	6·5	15	2·81
		Aug.	29·764	1·153	76·4	42·2	34·2	66·4	51·6	14·8	58·6	50·9	·370	4·2	1·3	76	531	112·6	49·0	0·6	6	4	4	17	—	6·6	12	1·51
		Sept.	29·735	1·184	70·9	40·9	30·0	61·6	49·7	11·9	55·5	48·8	·347	3·9	0·9	79	534	101·9	43·0	0·4	5	7	7	11	—	6·6	14	2·32

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1882. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean Of all Highest.	Mean Of all Lowest.	Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	In a cubic foot of Air. Mean.	In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Sat^n = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Minimum on Grass.	Wind. Estimated Strength.	Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in	grs.	gr.		grs.	°	°									in.
SOMERLEYTON (Suffolk), The Rectory, Rev. C. J. Steward, F.M.S.	50	July	29·786	1·050	75·0	44·0	31·0	67·8	51·6	16·2	58·1	52·4	·295	4·4	1·0	81	530	—	—	1·0	2	3	12	14	6·3	5·9	18	2·74
		Aug.	29·808	1·172	74·0	41·0	33·0	67·1	51·4	15·7	58·1	51·8	·387	4·3	1·1	79	532	—	—	1·0	5	5	7	11	6·2	5·5	12	1·87
		Sept.	29·781	1·178	71·0	42·0	29·0	62·1	49·1	13·0	54·6	49·7	·357	4·0	0·8	84	536	—	—	1·0	8	7	5	10	5·8	5·9	12	2·43
WOLVERHAMPTON (Staffordshire), Wrottesley, E. Simpson, Esq.	500	July	29·299	1·118	74·0	44·5	29·5	67·2	50·3	16·9	57·2	49·7	·365	4·1	1·2	78	524	—	—	—	3	2	22	4	—	7·9	21	3·72
		Aug.	29·368	1·056	78·6	44·0	34·6	65·8	51·0	14·8	56·6	50·1	·362	4·1	1·0	79	526	—	—	—	8	3	8	12	—	5·3	15	1·95
		Sept.	29·348	1·170	64·8	36·5	28·3	59·6	45·0	14·6	51·3	46·6	·319	3·6	0·7	84	532	—	—	—	8	6	8	8	—	6·9	14	2·24
LEICESTER (Town Museum), J. C. Smith, Esq.	238	July	29·557	1·180	74·3	46·8	27·5	69·6	52·3	17·3	59·4	51·5	·360	4·2	1·1	75	527	124·0	44·8	0·8	1	3	13	14	—	7·0	24	3·30
		Aug.	29·618	1·174	79·0	42·0	37·0	67·8	51·8	16·0	58·8	50·7	·370	4·2	1·3	75	529	116·7	[illegible]	0·7	6	3	8	14	—	6·0	15	2·17
		Sept.	29·590	1·196	69·5	34·0	35·5	63·0	46·2	16·8	53·8	47·9	·332	3·7	0·9	80	535	105·4	36·8	0·6	8	5	7	10	—	5·9	18	2·54
NOTTINGHAM (Notts), M. O. Tarbotton, Esq., C.E., F.G.S., F.M.S.	183	July	29·602	1·166	76·8	41·2	32·6	71·4	51·0	20·4	59·4	53·2	·405	4·5	1·2	81	527	117·2	50·6	0·3	2	2	16	11	1·7	6·7	23	3·31
		Aug.	29·657	1·218	77·6	42·6	35·0	68·8	50·6	18·2	58·3	50·5	·368	4·1	1·3	75	530	115·1	48·1	0·3	5	4	8	14	0·9	6·3	21	1·42
		Sept.	29·641	1·198	67·4	33·5	33·9	62·8	45·3	17·5	53·2	48·0	·335	3·8	0·8	82	535	92·4	44·1	0·2	9	9	7	5	0·7	6·4	20	2·22
HOLKHAM (Norfolk), John Davidson, Esq., Assistant to the Earl of Leicester.	39	July	29·768	1·480	72·5	34·2	38·3	68·2	47·5	20·7	58·8	54·5	·457	5·0	0·5	92	531	133·4	41·2	1·6	6	1	21	3	—	6·1	18	1·76
		Aug.	29·804	1·212	76·5	38·6	37·9	67·0	48·4	18·6	57·8	54·8	·430	4·7	0·6	91	533	125·8	40·3	1·4	12	1	11	7	—	6·8	12	2·00
		Sept.	29·763	1·158	69·6	32·0	37·6	61·3	43·2	18·1	52·7	47·3	·327	3·7	0·8	82	538	109·3	34·9	1·3	16	3	7	4	—	6·4	12	2·48
LLANDUDNO (Carnarvonshire), James Nicol, Esq., M.D.	197	July	29·676	1·300	70·0	49·2	20·8	64·3	50·5	13·8	57·0	50·5	·372	4·1	1·1	80	531	—	—	0·9	3	2	13	13	—	7·2	18	2·55
		Aug.	29·790	1·110	70·6	49·8	20·8	63·5	54·1	9·4	57·9	52·6	·397	4·4	1·0	81	532	—	—	0·8	6	1	6	18	—	8·0	15	3·55
		Sept.	29·750	1·220	67·2	42·0	25·2	59·2	49·3	9·9	54·1	48·0	·333	3·8	0·9	79	536	—	—	0·8	5	4	9	12	—	6·4	18	1·96
LIVERPOOL, The Observatory, John Hartnup, Esq., F.R.A.S.	197	July	29·564	1·183	70·3	48·9	21·4	65·0	53·2	11·8	57·6	52·6	·407	4·5	0·8	85	529	—	—	—	5	3	14	9	—	6·9	25	4·25
		Aug.	29·632	1·196	74·1	48·1	26·0	63·5	54·1	9·4	57·4	51·1	·376	4·2	1·1	80	531	—	—	—	1	3	4	23	—	7·0	16	2·36
		Sept.	29·633	1·216	65·9	41·3	24·4	59·5	49·0	10·5	53·3	48·7	·343	3·9	0·7	84	534	—	—	—	4	8	8	10	—	6·7	17	2·41
BOLTON, Sharples (Lancashire), Rev. T. Mackereth, F.R.A.S., F.M.S.	500	July	29·258	1·246	72·0	44·7	27·3	64·1	49·8	14·3	55·6	50·8	·372	4·1	0·5	85	525	78·7	43·9	1·1	3	3	13	12	1·3	7·9	29	6·70
		Aug.	29·312	1·168	73·7	42·0	31·7	63·5	49·8	13·7	55·7	50·8	·371	4·2	0·8	85	526	80·4	34·1	1·4	8	3	8	12	4·2	7·7	20	5·81
		Sept.	29·307	1·174	64·5	38·0	26·5	59·5	45·6	13·9	51·9	46·7	·319	3·6	0·8	83	530	72·4	39·5	1·0	8	6	9	7	2·0	6·7	17	2·80
HALIFAX, Bermerside Observatory (Yorkshire), E. J. Crossley, Esq., F.R.A.S.	530	July		1·168	74·0	43·0	31·0	67·1	49·8	17·3	56·8	53·0	·388	4·3	0·8	84	—	118·2	43·5	—	1	3	11	13	—	—	20	3·20
		Aug.	29·342	1·116	80·3	42·0	38·3	67·9	49·7	18·2	57·2	50·6	·370	4·1	1·2	79	525	112·9	—	—	2	3	12	14	—	6·4	18	1·95
		Sept.	29·318	1·136	70·9	34·2	36·7	62·1	43·2	18·9	51·5	45·8	·315	3·4	0·9	81	531	92·1	—	—	4	6	9	11	—	7·2	12	1·71
HULL (Yorkshire), The People's Park, Mr. E. Peak.	12	July	29·802	1·132	76·0	38·0	38·0	71·1	49·9	21·2	59·5	51·4	·380	4·3	1·3	76	531	103·8	48·1	1·1	1	3	14	13	1·1	6·8	18	1·98
		Aug.	29·855	1·218	79·0	38·0	41·0	69·2	49·1	20·1	58·5	52·9	·389	4·5	1·2	89	533	101·1	46·6	1·2	2	3	4	22	2·7	6·1	19	3·18
		Sept.	29·849	1·102	72·0	31·0	41·0	65·0	42·9	22·1	53·7	47·6	·329	3·9	0·9	78	538	92·1	39·8	1·0	6	3	4	17	1·2	5·6	15	1·60
STONYHURST (Lancashire), Rev. S. J. Perry, F.R.S., F.M.S., F.R.A.S.	363	July	29·389	1·260	76·8	48·8	28·0	67·5	53·4	14·1	57·6	52·7	·398	4·4	0·9	83	525	125·5	52·1	—	0	2	12	17	—	7·7	24	7·89
		Aug.	29·469	1·196	76·5	48·5	28·0	66·5	54·0	12·5	56·7	54·3	·421	4·7	0·5	92	528	125·5	50·6	—	1	1	5	24	—	7·5	16	5·33
		Sept.	29·458	1·183	64·4	34·9	31·5	61·7	45·0	16·7	52·6	47·1	·323	3·6	0·7	82	532	109·4	43·8	—	7	2	6	15	—	6·9	15	3·12
BRADFORD (Yorkshire), J. McLandsborough, Esq., C.E., F.G.S.	366	July	29·389	1·164	73·8	46·0	27·8	66·5	53·3	13·2	58·0	49·1	·350	3·9	1·5	73	524	88·7	—	0·9	3	2	13	13	—	6·6	26	4·12
		Aug.	29·440	1·264	77·4	46·3	31·1	66·9	53·1	13·8	58·3	49·0	·348	3·9	1·6	72	526	87·9	—	1·0	8	3	7	13	—	5·8	19	1·64
		Sept.	29·432	1·185	66·5	38·1	28·4	60·6	47·9	12·7	53·0	46·4	·315	3·5	1·0	78	531	76·3	—	0·9	7	6	5	12	—	6·2	13	1·99
LEEDS (Yorkshire), The Philosophical Hall, Henry Crowther, Esq.	137	July	29·632	1·170	74·0	47·0	27·0	68·5	53·0	15·5	59·7	53·7	·411	4·6	1·2	80	526	88·7	—	1·2	3	3	10	15	—	6·7	22	5·04
		Aug.	29·605	1·262	76·0	46·0	30·0	68·0	52·6	15·4	59·8	44·8	·429	4·7	1·0	84	528	75·4	—	1·2	5	6	5	15	—	5·3	14	1·63
		Sept.	29·687	1·180	73·0	38·0	35·0	63·1	47·1	16·0	54·3	50·9	·373	4·2	0·6	84	534	—	—	1·3	7	6	5	12	—	6·2	14	1·54
LANCASTER (Southfields), William Roper, Esq.	114	July	29·616	1·178	75·0	46·0	29·0	65·0	50·9	14·1	57·0	50·4	·367	4·1	1·5	79	530	—	—	—	—	—	—	—	—	—	25	5·97
		Aug.	29·728	1·111	74·0	42·0	32·0	64·8	51·7	13·1	57·1	51·1	·376	4·2	1·0	80	532	—	—	—	—	—	—	—	—	—	13	3·71
		Sept.	29·700	1·141	69·0	39·0	30·0	61·0	45·9	15·1	54·0	46·2	·303	3·5	1·0	78	536	—	—	—	—	—	—	—	—	—	16	2·44

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1882. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean Of all Highest.	Temperature of Air in Month. Mean Of all Lowest.	Temperature of Air in Month. Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity, Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
SILLOTH (Cumberland), "The Rectory," Rev. F. Redford, M.A., F.R.A.S., F.M.S.	28	July	29·710	1·250	72·1	46·7	25·4	66·0	52·5	13·5	57·6	52·4	·392	4·4	1·1	82	531	120·6	50·2	1·4	1	2	8	20	6·5	6·6	24	5·16
		Aug.	29·799	1·156	75·3	38·0	37·3	66·7	51·0	15·7	56·6	52·1	·392	4·3	1·2	82	533	121·6	48·1	1·2	8	4	6	13	7·2	5·7	17	2·64
		Sept.	29·790	1·319	67·3	36·0	31·3	61·6	46·1	15·5	53·0	45·8	·310	3·5	1·0	76	538	110·0	43·4	1·1	5	7	9	9	7·1	5·6	14	2·16
CARLISLE, Spital (Cumberland), Isaac Cartmel, Esq., F.M.S.	114	July	29·601	1·256	76·8	44·0	32·8	69·0	50·2	18·8	57·8	53·3	·407	4·5	0·8	84	529	102·9	44·0	0·8	2	8	9	12	4·3	7·8	22	4·66
		Aug.	29·693	1·122	77·8	36·3	41·5	67·3	49·4	17·9	57·8	50·6	·358	4·1	1·2	77	531	97·5	43·1	0·7	2	8	6	15	3·8	7·7	13	3·08
		Sept.	29·697	1·202	70·2	33·5	36·7	62·9	45·1	17·8	53·2	46·8	·320	3·6	1·0	79	536	92·7	37·5	0·4	5	9	6	10	3·3	6·1	14	1·88

Second Rain-gauges are placed—

			July.		August.		September.		Total in Quarter.
At Eastbourne, at the height of	160 feet *above the sea*;	the amount collected was	2·71 inches.	-	2·57 inches.	-	3·28 inches.	-	8·51 inches.
" Beachy Head, "	515 " "	"	2·02 "	-	2·33 "	-	2·78 "	-	7·13 "
" " "	495 " "	"	2·07 "	-	2·20 "	-	2·96 "	-	7·23 "
" Oxford, "	22 " *ground*	"	2·94 "	-	0·88 "	-	2·35 "	-	6·17 "
" Nottingham, "	89 " "	"	3·04 "	-	1·30 "	-	2·04 "	-	6·38 "
" Holkham, "	4 " "	"	1·78 "	-	2·00 "	-	2·48 "	-	6·26 "

NAMES OF STATIONS.	Mean Pressure of dry Air reduced to the level of the Sea.	Highest Reading of the Thermometer.	Lowest Reading of the Thermometer.	Range of Temperature in the Quarter.	Mean of all Highest.	Mean of all Lowest.	Mean Monthly Range of Temperature.	Mean Daily Range of Temperature.	Mean Temperature of the Air.	Mean Temperature of the Dew Point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Mean Reading of Maximum in Rays of Sun.	Mean Reading of Minimum on Grass.	Wind: Mean Estimated Strength.	Wind: N.	Wind: E.	Wind: S.	Wind: W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Number of Days on which it fell.	Rain
	in.	°	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									
Guernsey	29·737	78·0	41·[illegible]	36·5	64·5	53·4	23·4	10·8	57·8	53·1	·404	4·5	0·9	84	530	115·2	49·0	1·0	7	2	6	16	3·[illegible]	5·8	51	[illegible]
Truro	29·492	78·0	35·0	43·0	63·6	51·8	43·0	14·8	56·9	51·4	·381	4·3	1·0	82	537	—	—	2·5	6	3	7	15	—	6·9	47	[illegible]
Plymouth	29·489	78·1	37·8	40·3	63·6	52·[illegible]	28·[illegible]	12·9	57·7	53·0	·404	4·5	0·9	84	533	—	—	1·7	6	4	11	10	—	6·3	49	[illegible]
Totnes	29·593	80·2	30·4	49·8	66·4	49·[illegible]	36·1	16·9	57·3	50·[illegible]	·366	4·2	1·2	80	534	—	—	2·4	6	4	8	13	—	5·7	51	[illegible]
Torquay	29·544	78·2	36·9	41·3	65·6	51·1	28·7	13·5	57·1	50·5	·368	4·2	1·1	78	529	122·4	44·[illegible]	2·2	6	4	7	14	4·[illegible]	6·1	47	[illegible]
Ventnor	29·472	77·2	44·2	33·0	63·0	54·[illegible]	25·0	11·9	58·4	53·7	·411	4·6	0·[illegible]	85	532	—	—	1·7	6	4	5	15	3·[illegible]	6·6	44	[illegible]
Eastbourne	29·498	75·5	46·0	29·[illegible]	63·8	52·[illegible]	27·1	14·7	59·5	52·8	·402	4·[illegible]	1·0	79	532	115·8	46·[illegible]	0·[illegible]	6	[illegible]	7	15	1·[illegible]	—	42	[illegible]
Osborne	29·400	81·9	39·3	45·6	68·6	51·9	32·6	14·7	58·[illegible]	55·[illegible]	·418	5·0	0·[illegible]	89	530	119·6	48·1	0·[illegible]	5	3	10	12	—	5·6	43	[illegible]
Southbourne	29·510	79·[illegible]	37·0	44·[illegible]	65·1	51·5	30·5	13·8	57·9	51·[illegible]	·[illegible]	4·2	1·1	79	53[illegible]	—	—	1·4	7	4	7	12	—	5·8	45	[illegible]
Salisbury	29·702	82·[illegible]	30·0	52·0	69·1	46·[illegible]	38·[illegible]	22·6	57·0	48·5	·385	4·3	1·0	82	532	112·4	43·[illegible]	1·[illegible]	1[illegible]	3	7	11	—	5·7	50	[illegible]
Barnstaple	29·469	82·6	36·0	46·0	67·5	51·[illegible]	30·[illegible]	12·7	59·8	54·[illegible]	·422	4·7	1·[illegible]	82	531	—	—	1·1	5	3	9	14	—	3·[illegible]	53	[illegible]
Bath	29·500	72·4	37·[illegible]	35·2	62·9	50·[illegible]	35·0	12·7	55·4	50·[illegible]	·[illegible]	4·1	0·9	83	525	—	—	1·[illegible]	7	3	8	13	—	6·8	—	[illegible]
Strathfield Turgiss	29·511	83·2	32·7	50·5	68·2	48·4	39·2	19·8	58·0	51·[illegible]	·378	4·2	1·2	79	530	116·4	42·[illegible]	1·0	5	4	8	14	2·[illegible]	5·4	41	[illegible]
Marlborough	29·496	78·7	33·7	45·0	[illegible]	48·7	42·[illegible]	16·4	56·0	50·[illegible]	·361	4·1	1·[illegible]	81	527	116·9	—	0·[illegible]	7	5	8	11	—	[illegible]	46	[illegible]
Whitchurch	29·512	80·4	34·3	45·8	68·3	47·5	36·3	20·8	57·4	51·4	·357	4·5	1·0	81	532	—	—	1·4	6	5	8	12	—	6·[illegible]	47	[illegible]
Blackheath	29·503	81·0	37·5	43·5	67·6	51·8	32·2	15·8	58·3	50·5	·376	4·2	1·5	77	531	113·1	46·[illegible]	1·[illegible]	5	3	10	12	—	5·7	49	[illegible]
Royal Observatory	29·480	81·0	36·7	44·3	65·5	50·[illegible]	44·8	18·[illegible]	58·1	52·1	·391	4·4	1·0	81	530	121·9	42·[illegible]	—	—	—	—	—	4·6	6·8	48	[illegible]
Camden Square	29·[illegible]	81·8	37·8	41·0	68·9	51·0	33·8	17·9	58·6	50·6	·370	4·1	1·8	75	531	109·3	47·[illegible]	—	10	3	6	11	—	5·2	39	[illegible]
Barnet	29·531	79·5	32·5	47·0	67·7	47·7	48·4	20·0	56·6	50·8	·373	4·1	1·0	81	532	123·4	40·[illegible]	1·[illegible]	9	5	5	12	—	6·6	58	[illegible]
Oxford	29·579	78·7	35·7	42·0	65·3	51·0	40·1	15·4	58·2	52·[illegible]	·[illegible]	4·4	1·1	80	529	116·7	45·5	2·[illegible]	5	4	12	10	1·0	6·5	43	[illegible]
Royston	29·522	82·1	36·0	46·1	67·4	49·5	46·2	17·9	56·9	51·0	·371	4·2	1·0	80	531	—	—	—	7	3	8	13	—	6·[illegible]	36	[illegible]
Bedford	29·434	79·[illegible]	[illegible]4·0	45·0	68·3	48·8	46·4	19·[illegible]	57·9	52·0	·400	4·5	1·0	83	531	102·3	45·[illegible]	1·[illegible]	7	3	8	13	—	6·[illegible]	45	[illegible]
Cambridge	29·452	83·0	31·5	52·5	70·8	49·4	40·8	21·4	58·5	52·1	·391	4·4	1·1	80	532	132·1	42·8	1·0	8	4	10	9	—	6·3	48	[illegible]
Lowestoft	29·481	76·4	40·9	35·5	65·0	51·2	41·2	13·8	57·7	50·7	·[illegible]	4·1	1·2	78	532	111·1	47·[illegible]	0·[illegible]	4	4	7	15	—	6·[illegible]	41	[illegible]
Somerleyton	29·536	74·0	41·0	33·0	65·7	50·7	41·[illegible]	15·0	56·9	51·[illegible]	·380	4·2	1·0	81	533	—	—	1·[illegible]	5	5	8	13	6·1	5·8	42	[illegible]
Wolverhampton	29·521	78·6	36·5	42·1	64·2	48·8	40·8	15·4	55·0	48·[illegible]	·348	3·9	1·0	80	527	—	—	—	6	4	13	4	—	6·[illegible]	50	[illegible]
Leicester	29·184	79·0	31·0	47·0	65·8	50·1	33·3	16·7	57·[illegible]	50·0	·[illegible]	4·0	1·1	77	530	115·4	41·[illegible]	0·7	5	4	9	13	—	6·5	37	[illegible]
Nottingham	29·461	77·6	33·5	44·1	67·7	49·0	43·8	18·7	57·[illegible]	50·6	·369	4·1	1·1	79	531	108·2	47·6	0·[illegible]	5	5	10	10	1·[illegible]	6·2	64	[illegible]
Holkham	29·415	77·[illegible]	32·[illegible]	44·5	65·5	48·4	47·8	19·1	56·3	52·[illegible]	·405	4·5	0·6	88	534	122·8	38·[illegible]	1·4	11	2	13	5	—	6·4	42	[illegible]
Llandudno	29·583	70·[illegible]	42·0	28·6	62·[illegible]	51·3	22·[illegible]	11·0	56·5	50·4	·367	4·1	1·[illegible]	81	533	—	—	0·8	5	2	9	14	—	7·2	51	[illegible]
Liverpool	29·456	74·1	41·5	32·4	62·7	52·1	23·9	10·6	56·1	50·8	·[illegible]75	4·2	0·9	83	531	—	—	—	3	3	8	14	—	6·9	58	[illegible]
Bolton	29·563	73·7	38·0	35·7	62·4	48·4	28·5	14·0	54·4	49·4	·354	4·0	0·7	84	527	77·2	42·[illegible]	1·[illegible]	6	4	10	10	3·8	7·4	66	[illegible]
Halifax	—	80·[illegible]	34·2	46·1	65·7	47·6	33·3	18·[illegible]	55·2	49·8	·356	3·9	1·0	81	—	107·7	—	—	2	4	12	13	—	—	50	[illegible]
Hull	29·482	79·0	31·0	48·0	68·4	47·3	40·0	21·1	57·2	50·3	·360	4·2	1·1	81	534	99·0	44·8	1·1	3	3	7	17	1·[illegible]	6·2	52	[illegible]
Stonyhurst	29·446	73·5	34·9	41·6	63·2	50·8	29·2	14·4	55·6	51·4	·381	4·2	0·7	86	529	120·1	48·8	—	3	2	7	19	—	7·4	55	[illegible]
Bradford	29·470	77·4	38·1	39·3	64·7	51·4	29·1	13·2	54·4	48·[illegible]	·338	3·7	1·4	74	527	84·3	—	0·4	6	4	8	13	—	6·[illegible]	58	[illegible]
Leeds	29·414	76·6	38·0	38·0	63·5	50·9	30·7	15·0	57·1	49·8	·404	4·5	0·9	83	529	—	—	1·[illegible]	5	3	7	14	—	5·1	50	[illegible]
Lancaster	29·440	75·0	39·0	36·0	63·6	49·5	30·5	14·1	55·7	49·2	·349	3·[illegible]	1·2	79	533	—	—	—	—	—	—	—	—	—	36	[illegible]
Silloth	29·431	75·[illegible]	36·0	39·3	64·8	49·0	41·5	14·9	56·1	50·1	·365	4·1	1·1	80	534	118·4	47·[illegible]	1·[illegible]	5	4	8	14	6·[illegible]	6·[illegible]	55	[illegible]
Carlisle	29·421	77·[illegible]	33·5	44·3	63·4	48·2	37·0	18·[illegible]	56·5	50·5	·365	4·1	1·0	80	532	97·7	41·[illegible]	0·[illegible]	3	8	7	12	3·[illegible]	7·2	43	[illegible]

The highest temperatures of the air were at Cambridge, 86° ; at Osborne, 84°·9 ; and at Strathfield Turgiss, 85°·2, and there were August

The lowest temperatures of the air were at Salisbury, 30° ; at Totnes, 30·4 ; and at Hull, 31°.

The greatest daily ranges of temperatures were at Salisbury, 22° ; at Cambridge, 21°·4 ; and at Hull, 21°·1.

The least daily ranges of temperatures were at Liverpool, 10·6 ; at Guernsey 10°·8 ; at Llandudno, 11° ; and at Ventnor, 11°·9.

The greatest number of days of rain were at Bolton 66 ; at Nottingham, 64 ; and at Liverpool and Bradford, 58.

The least number of days of rain were at Royston, 36 ; at Barnet, 38 ; and at Camden Square, 39.

The heaviest falls of rain in the quarter were at Stonyhurst, 16·34 inches ; at Barnstaple, 15·55 inches ; and at Bolton, 15·31 inches.

The least falls of rain in the quarter were at Royston, 7·8 inches ; at Strathfield Turgiss, 5·86 inches ; and at Cambridge, 5·90 inches.

ERRATA.—Quarter ending 30th June 1882, *for* the greatest daily ranges of temperature were, Rugby, 33°·1 ; at Nottingham and Carlisle 32°·0 ; and at Salisbury and Gloucester, 49°·0 ; *read* Salisbury, 23°·3 ; at Gloucester, 21°·8 ; and at Rugby, 21°·7.

QUARTERLY METEOROLOGICAL TABLE for different PARALLELS of LATITUDE.

PARALLELS OF LATITUDE, &c.	Mean Pressure of dry Air reduced to the level of the Sea.	Mean of all Highest Readings of the Thermometer.	Mean of all Lowest Readings of the Thermometer.	Mean Range of Temperature in the Quarter.	Mean of all Highest.	Mean of all Lowest.	Mean Monthly Range of Temperature.	Mean Daily Range of Temperature.	Mean Temperature of the Air.	Mean Temperature of the Dew Point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Mean Reading of Maximum in Rays of Sun.	Mean Reading of Minimum on Grass.	Wind: Mean Estimated Strength.	Wind: N.	Wind: E.	Wind: S.	Wind: W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Mean Number of Days it fell.	Rain: Mean Amount collected.
	in.	°	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
Guernsey	29·737	78·0	41·5	36·5	64·3	53·4	23·4	10·8	57·8	53·1	·404	4·5	0·9	84	530	115·2	49·0	1·0	7	2	6	16	[illegible]	[illegible]	51	[illegible]
Between the latitudes 50° and 51°	29·496	79·0	[illegible]8·1	40·9	66·2	51·8	30·0	14·4	57·7	52·3	·394	4·4	1·0	82	532	119·3	47·5	1·5	6	4	8	13	[illegible]	[illegible]	46	[illegible]
51° and 52°	29·520	80·7	36·7	45·9	67·7	49·8	35·1	18·0	57·8	51·2	·384	4·3	1·1	80	531	116·3	44·1	1·3	7	4	8	12	[illegible]	[illegible]	46	[illegible]
52° and 53°	29·482	78·8	35·8	43·1	66·8	49·3	34·6	17·6	57·1	51·0	·[illegible]	4·2	1·0	81	531	115·3	43·9	0·9	6	4	10	10	3·[illegible]	[illegible]	48	[illegible]
53° and 54°	29·480	76·1	36·2	39·2	64·9	49·7	30·7	15·2	56·0	49·8	·364	4·4	1·0	81	530	97·7	45·4	1·0	4	5	9	14	2·[illegible]	[illegible]	55	[illegible]
54° and 55°	29·427	76·6	34·8	41·8	65·6	49·0	34·2	16·6	56·2	50·2	·3[illegible]	4·[illegible]	1·0	80	533	108·0	41·4	1·0	4	6	7	13	[illegible]	6	52	[illegible]
Mean for the Quarter, 50° to 55°: Year 1879	29·46	77·2	37·1	40·1	64·7	50·8	31·6	13·9	56·5	51·4	·3[illegible]	4·3	0·8	84	531	102·0	46·6	1·3	5	5	8	13	[illegible]	[illegible]	[illegible]	[illegible]
1880	29·524	82·7	41·9	40·8	68·5	52·9	34·5	15·6	59·5	54·1	·420	4·7	1·0	83	530	111·2	48·5	1·0	6	7	7	11	5·[illegible]	[illegible]	[illegible]	[illegible]
1881	29·533	84·1	39·1	46·4	66·5	50·7	37·0	15·8	57·4	54·7	·385	4·3	1·0	81	532	106·4	45·2	1·0	6	4	7	14	2·[illegible]	[illegible]	[illegible]	[illegible]
1882	29·480	78·3	36·1	42·2	66·5	49·9	32·9	16·4	56·9	50·9	·376	4·3	1·0	81	531	111·8	45·0	1·2	5	4	8	12	3·7	6·[illegible]	[illegible]	[illegible]